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January 15, 1968

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Volume 22, Number 1, January 15, 1968

NUCLEAR SCIENCE ABSTRACTS

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                              1967)
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NUCLEAR SCIENCE ABSTRACTS

CHEMISTRY

Analytical Chemistry

Refer also to abstracts 159, 172, 250, 251, 254–257, 262, 311, and 472.

1 (AECL–2770) DETERMINATION OF OXIDES OF NITROGEN IN REACTOR LOOP COVER GAS. Denovan, A. S.; Ashley, R. W. (Atomic Energy of Canada Ltd., Chalk River (Ontario). Chalk River Nuclear Labs.). Sept. 1967. 12p. Dep. CFSTI. CAN.

Oxides of nitrogen, in reactor loop cover gas consisting of CO_2 with up to 2% air, can be quantitatively collected using selective absorbers and then determined by gas chromatography. Statistical evaluation of the data used to obtain calibration curves gave standard deviations of ±3.2 μg for NO, ±2.6 μg for NO_2 and ±5.5 μg for N_2O over the range of 15 to 150 μg. Limits of detection for the 3 gases are: NO, 200 ppB; NO_2, 60 ppB; and N_2O, 200 ppB. (auth)

2 (AEEW-M–745) FUNDAMENTAL CALCULATIONS AND ESTIMATION OF ACCURACY IN HEAVY WATER STANDARDS. Rowland, P. R. (Atomic Energy Establishment, Winfrith (England)). May 1967. 21p. Dep. CFSTI. UK 3s. 6d.

The theoretical relation between density and heavy water concentration was re-examined and it is shown that a simple linear relation exists between concentration expressed as weight fraction and reciprocal density. The fundamental constants in this equation are critically reviewed, and it is shown that world standards differ by an amount equivalent to 0.05% on Reactor Grade Water. In terms of neutron behaviour this represents 3% of the lifetime of a natural uranium reactor (200 MWD/tonne). The major sources of error in the estimation of heavy water by density determination are analysed and methods to obviate them are enumerated. (auth)

3 (AERE-R–5254) THE DISTRIBUTION OF SOME TRACE ELEMENTS IN IRON METEORITES, AS DETERMINED BY NEUTRON ACTIVATION. PART 2. ANALYTICAL METHODS. Smales, A. A.; Mapper, D.; Fouche, K. F. (Atomic Energy Research Establishment, Harwell (England)). Aug. 1967. 20p. Dep. CFSTI. UK 3s. 0d.

The eleven trace elements Ge, Ga, As, Sb, Cu, Cr, Mo, Ag, In, Zn, and Pd, were determined in 67 iron meteorites, using neutron activation and radiochemical separations. The complete results were published and discussed (Geochim. Cosmochim. Acta 31, 673, 1967). A detailed account is given of the analytical methods used, including those used for some absorptiometric determination of gallium and sulfur. (auth)

4 (AERE-R–5452) ANALYSIS OF SOME EXPERIMENTAL BINARY ALLOYS USING X-RAY FLUORESCENCE AND CHEMICAL METHODS. Garton, F. W. J.; Parker, A.; Watling, J. (Atomic Energy Research Establishment, Harwell (England)). Aug. 1967. 12p. Dep. CFSTI. UK 2s. 6d.

The X-ray fluorescence analysis of a number of binary alloys using an automated Philips PW 1520 x-ray spectrometer is described. Solution techniques were generally employed, although some applications using powders are also given. Satisfactory agreement was obtained with results from chemical methods of analysis. Data are tabulated. (auth) (UK)

5 (BNWL-SA–1388, pp 10.1-14) ANALYTICAL CHEMISTRY REQUIRED FOR THE FFTF FUEL CORE PROGRAM. Delvin, W. L. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

The analytical chemistry methods used to characterize materials used to fabricate FFTF fuel subassemblies are summarized. The materials are plutonium and uranium nitrate solutions, the starting materials for coprecipitated mixed oxides; plutonium and uranium dioxide, starting materials for mechanically-blended mixed oxides; mixed oxide fuels; stainless steel for cladding; and Ni for reflections. The available analytical methods are applied, but new methods are required to make use of new technology. (J.C.W.)

6 (CONF-661011, pp 135-45) ANALYTICAL EXCHANGE PROGRAM ON PLUTONIUM COMPOUNDS. Rodden, C. J. (New Brunswick Lab. (AEC), N. J.).

The program, along with a list of participating laboratories, for analysis of plutonium compounds to aid in accountability is described. Plutonium purchases are based on the ^{239}Pu and ^{244}Pu content and it is necessary to know the isotopic content as well as the total plutonium concentration. Results are given for plutonium isotopic assays on plutonium nitrate solutions. A comparison was made of results on U–Pu–Mo solutions. Data are tabulated. (J.C.W.)

7 (CONF-671012-2) IN-LINE α-COUNTERS. OPERATING EXPERIENCE GAINED AT THE MARCOULE PLUTONIUM EXTRACTION PLANT. Chabert, J. (Commissariat a l'Energie Atomique, Chusclan (France). Centre de Production de Plutonium de Marcoule). [nd]. 27p. Dep.

From 11th Conference on Analytical Chemistry in Nuclear Technology, Gatlinburg, Tenn.

Determining the plutonium concentration of solutions from fuel processing cycles by use of an in-line alpha counter is discussed. The analyzer consists of 5 components: mechanical sample presenter, scintillation detector, driving assembly, remotely controlled equipment, and associated electronic instrumentation. It is shown that use of a great number of continuously working alpha counters makes it possible to reduce the number of analyses. (M.C.G.)

8 (DPSPU–66-30-12) USE OF REACTION GAMMAS FOR ANALYSIS OF IMPURITIES IN ALPHA EMITTERS. McKibben, J. M. (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Plant). Nov. 1966. Contract AT(07-2)-1. 21p. (CONF-670401–12). Dep. CFSTI.

From 153rd National Meeting, American Chemical Society, Miami Beach, Fla.

With a gamma spectrometer, light element impurities in reaction with alpha particles can be identified by analysis of the resulting radiation, specifically gamma photons or "reaction gammas." This technique was successfully used on production lots of $^{238}PuO_2$ from which neutron emission rates were excessively high. At the inception of this work a catalog of possible reactions and, where known, their gamma energies was assembled. Because of deficiencies in these data it was necessary to determine experimentally the reaction gamma spectra for a number of light elements. This was done by measuring gamma spectra before and after addition of known quantities of these elements to $^{238}PuO_2$. Although some absolute emission rates of reaction gammas were obtained, this technique is largely qualitative rather than quantitative, because the gamma yield is highly dependent on the incident alpha particle energy and therefore on the homogeneity and purity of the sample. (auth)

9 (NBS-TN–425) MICROCHEMICAL ANALYSIS SECTION: SUMMARY OF ACTIVITIES, JULY 1966–JUNE 1967.

Taylor, John K. (ed.) (National Bureau of Standards, Washington, D. C.). Oct. 1967. 90p. GPO $0.50.

Research activities and scientific programs are reported for the period July 1966 to June 1967. General activities are reported in the areas of gas analysis, polarography, potentiometry, coulometry, chemical microscopy, and classical microchemical analysis. Research accomplishments described in some detail include the following: high pressure mass spectrometry; high precision differential polarography; an improved coulometric technique for titration of halides; developments in micro null-point potentiometry; techniques for the accurate weighing of small liquid samples. A number of microchemical procedures which have been developed for the analysis of a variety of materials are also included. (auth)

10 (ORNL-IIC-10(Vol.2), pp 576-86) HEAVY PARTICLE EXCITATION OF LOW-ENERGY CHARACTERISTIC X RADIATION. ANALYTICAL AND EXPERIMENTAL CORRELATIONS. Sellers, Bach; Wilson, Henry H.; Papadopoulos, John (Parametrics, Inc., Waltham, Mass.).

The interaction of heavy particles (alphas, protons) with matter results in the production of characteristic x radiation. Because of the large mass of such particles, little bremsstrahlung radiation is produced. Hence, the excitation spectra are relatively pure. The results of an attempt to find an analytical formulation for predicting the variation of x-ray yield with particle energy are presented, and the formulation is applied to yields measured in the low-Z region. Composition analysis of a multicomponent mixture by analysis of heavy-particle-excited characteristic x-radiation spectra is discussed. (auth)

11 (ORNL-IIC-10(Vol.2), pp 587-612) X-RAY ANALYSIS BY PROTON BOMBARDMENT. Marks, C. L.; Saylor, W. P.; Sterk, A. A. (American Machine and Foundry Co., Alexandria, Va.).

Characteristic x-ray emission lines created in targets subjected to proton bombardment were investigated. Production efficiencies were determined as a function of target material, and emitted x-ray wavelength for proton energies up to 100 keV. The method was applied to the study of thin films, with emphasis on thin deposits of carbon and oxygen. The low-energy protons have a small penetrating power and interact readily with thin films, resulting in a high x-ray yield, with x rays being emitted with a negligible amount of self-absorption. A special nondispersive detection technique was developed for the determination of trace amounts of oxygen. The method is based on selective filtering, with pure oxygen as the main absorbing element. Proton excitation promises to be a powerful analytical method for detecting low-atomic-number elements because: the excitation efficiency is high for soft x rays; radiation emission is a surface effect; and efficient nondispersive detection techniques can be used because no continuum is generated in the sample and the proton energy can be selected for optimum sensitivity. (auth)

12 NUCLEAR ACTIVATION TECHNIQUE FOR DETECTING ^{15}N TRACER IN SOLIDS. Condit, Ralph H.; Holt, J. Birch; Himmel, Lawrence (Univ. of California, Livermore). Contract W-7405-eng-48. J. Electrochem. Soc., 114: 1100-4(Nov. 1967). (UCRL-70429).

A technique for studying the transport of nitrogen in solids is described, which makes use of the nuclear activation, $^{15}N(\alpha,n)^{18}F$. The radioactivity of the product, ^{18}F, can be used to deduce the location of the original ^{15}N tracer by autoradiographic methods. Requirements for the success of this technique are discussed, and its application to the study of nitrogen diffusion in uranium mononitride is outlined. Other possible uses, i.e., the analysis for nitrogen or identification of nitride inclusions in solid, are also mentioned. (auth)

13 DETERMINATION OF SELENOMETHIONINE IN BIOLOGICAL SOURCES BY CHROMATOGRAPHY AND NEUTRON ACTIVATION ANALYSIS. Barak, Anthony J.; Swanberg, Stacy C. (Veterans Administration Hospital, Omaha). J. Chromatogr., 31: 282-4(Nov. 1967).

A method was developed for determining selenomethionine, 2-amino-4(methylselenyl)butyric acid, in the presence of methionine in serum, liver, and muscle by combining the techniques of paper chromatography and neutron activation analysis. Recovery from liver and muscle homogenates was 100%, from serum—60%. The lower limit of detectability of the method is 0.1 mole of selenomethionine per g of tissue or per ml of serum. (J.G.B.)

14 CHROMATOGRAPHY ON PAPER IMPREGNATED WITH INORGANIC ION EXCHANGERS. IV. SPOT TEST FOR Tl(I), Hg(I), Ag(I), AND Cs(I) AFTER RAPID AND SELECTIVE CHROMATOGRAPHIC SEPARATION ON AMMONIUM MOLYBDOPHOSPHATE PAPER. Alberti, G. (CNEN, Rome. Univ., Rome. J. Chromatogr., 31: 177-81(Nov. 1967).

Spot tests for Tl(I), Ag(I), Hg(I), and Cs(I), in the presence of interfering substances, were carried out after a very fast chromatographic separation on paper impregnated with ammonium molybdophosphate (AMP). The time required, in some cases, is less than 60 sec. The chromatographic behavior of several inorganic ions on AMP paper is also reported. (auth)

15 RHENIUM AND OSMIUM ABUNDANCES IN CHONDRITIC METEORITES. Morgan, J. W.; Lovering, J. F. (Australian National Univ., Canberra). Geochim. Cosmochim. Acta, 31: 1893-1909(Oct. 1967).

The abundances of Re and Os in thirty-two chondrites representing all classes were determined by neutron activation analysis. Some disagreement with previous determinations of Os in ordinary chondrites can be explained by the difficulties of sampling for siderophilic elements when metallic nickel–iron is present. Considerable fractionation of Re and Os between chondrite classes was apparent, and could not be interpreted solely on the basis of transfer of metallic phase rich in these two elements. Solar atomic abundances relative to 10^6 atoms Si calculated from the mean of all chondrites analyzed, were 0.053 atoms Re and 0.61 atoms Os. (auth) (UK)

16 SILICON ABUNDANCES IN METEORITIC CHONDRULES. Schmitt, R. A. (General Atomic Div., General Dynamics Corp., San Diego, Calif. Oregon State Univ., Corvallis); Smith, R. H.; Ehmann, W. D.; McKown, D. Contracts AT(40-1)-2670; NASw-843. Geochim. Cosmochim. Acta, 31: 1975-85(Oct. 1967).

Silicon abundances were determined in some 275 chondrules (masses ranging from 0.1 to 70 mg) from nineteen different chondrites from most chondritic groups by 14-MeV neutron activation analysis, using the nuclear reaction $^{28}Si(n,p)^{28}Al$. Average Si abundances at about 20% in chondrules from Type II carbonaceous chondrites agreed well with a forsterite composition for these chondrules. In general, ca 25% more Si was present in chondrules than in the bulk chondrites. Very low Si abundances (0.6 to 25%) were observed in some Al Rais, Renazzo, and Tennasilm chondrules. This hiatus in Si abundances of ≈2% and ≈20% suggests that meteoritic chondrules may have originated from two different sources in the solar nebula, or were formed from the same nebular source but under changing temperature-pressure conditions. (auth) (UK)

17 ABUNDANCE OF ANTIMONY IN METEORITES, TEKTITES, AND ROCKS BY NEUTRON ACTIVATION ANALYSIS. Tanner, James T.; Ehmann, William D. (Univ. of Kentucky, Lexington). Contract AT(40-1)-2670. Geochim. Cosmochim. Acta, 31: 2007-26(Oct. 1967).

Antimony was determined by neutron activation in twenty-four chondrites, eight achondrites, three siderites, five separated meteoritic phases, twelve tektites, six natural glasses, eleven standard rocks, fifteen selected terrestrial rocks, and eight deep-sea sediments. The data confirm the expectation that antimony has appreciable siderophilic and chalcophilic properties in the meteorites. A cosmic atomic abundance for antimony of 0.40 ($Si = 10^6$) was obtained, based on two Type I carbonaceous chondrites analyzed. This value is considerably higher than was predicted by current theories of nucleosynthesis. The ordinary chrondrites are relatively uniform with respect to their antimony abundances, and average 0.11 ($Si = 10^6$). The relatively few analyses of terrestrial rocks and sediments reported suggest a rather complex geochemistry for antimony. Using the available data a crustal antimony abundance of approximately 0.2 ppM was indicated. (auth) (UK)

18 RARE-EARTH AND BARIUM ABUNDANCES IN IVORY COAST TEKTITES AND ROCKS FROM THE BOSUMTWI CRATER AREA, GHANA. Schnetzler, C. C.; Philpotts, John A.; Thomas, H. H. (Goddard Space Flight Center, Greenbelt, Md.). Geochim. Cosmochim. Acta, 31: 1987-93(Oct. 1967).

Abundances of eight rare earth elements and barium were determined by isotope dilution in an Ivory Coast tektite composite, an individual Ivory Coast tektite, two impactite glasses, and three country-rocks from the Bosumtwi Crater area of Ghana. The rare-earth abundances were lower, in general, than those in previously analyzed tektites from different geographic localities. There is some overlap in the data, however, and the differences may not be significant in view of the limited rare earth data on tektites. The rare-earth patterns of the meta-sedimentary country-rocks do not exactly match the patterns of the tektites, although there are general similarities. On the other hand, the Bosumtwi Crater impact glasses have rare-earth and barium abundances that are virtually identical to those in the tektites. This identity is viewed as supporting evidence that the Ivory Coast tektites were produced terrestrially by the impact that formed the Bosumtwi Crater. (auth) (UK)

19 ABUNDANCE AND DISTRIBUTION OF CHLORINE IN IRON METEORITES. Berkey, E.; Fisher, D. E. (Cornell Univ., Ithaca, N. Y.). Geochim. Cosmochim. Acta, 31: 1543-58(Oct. 1967).

The abundance and distribution of chlorine in thirteen iron meteorites was studied by neutron activation analysis and metallographic examination. It was found that terrestrial processes have affected the Cl in some finds, and that weathering can lead to severe contamination effects, raising the Cl content over localized regions by many orders of magnitude. The contamination process appears to act in conjunction with the penetration of ground water into the interior. The pathways utilized were cleavages, grain boundaries, Neumann lines, and even direct passage through the matrix. Measurements of primordial (non-terrestrial) Cl in the meteorites showed that it is inhomogeneously distributed in the metal phase, being strongly depleted in kamacite and accumulating near grain boundaries, around inclusions, and in chloride minerals. It was difficult to calculate an average value for the primordial Cl content of irons on the basis of the data obtained, but indications are that a representative value is much lower than previous data which were not sufficiently cognizant of contamination effects. (auth) (UK)

20 IODINE, URANIUM, AND TELLURIUM CONTENTS IN METEORITES. Clark, R. S.; Rowe, M. W.; Ganapathy, R.; Kuroda, P. K. (Univ. of Arkansas, Fayetteville). Geochim. Cosmochim. Acta, 31: 1605-13(Oct. 1967).

The abundances of iodine, uranium, and tellurium were determined in fifteen achondrites, five chondrites (two with light-dark structure), and three mesosiderites by neutron activation analysis. In thirty analyses on achondrites the following range of abundances was found: I, 14 to 1 ppM; U, 2 to 210 ppB, and Te, ≤0.03 to 3 ppM. These elements varied within a given class of achondrites and the individual achondrites showed a higher degree of heterogeneity than the chondrites. The iodine content of achondrites was of the same order as in chondrites. Uranium contents ranged higher, and tellurium lower in achondrites than in chondrites. Weaker correlation between iodine and tellurium was observed in achondrites than in chondrites. (auth) (UK)

21 ABUNDANCES OF CHLORINE, BROMINE, AND IODINE IN METEORITES. Goles, Gordon G.; Greenland, L. Paul; Jerome, Dominique Y. (Univ. of California, San Diego). Geochim. Cosmochim. Acta., 31: 1771-87(Oct. 1967).

Abundances of Cl, Br, and, in many cases, I, in eighteen chondritic meteorites, two octahedrites, and a terrestrial basalt were determined by neutron activation techniques. In general, the data are in agreement with those reported by previous authors, although some discrepancies are noted. Observations on a positive correlation of Cl : Br with Cl content in ordinary chondrites and on coherence of Cl, Br, and I in carbonaceous and enstatite chondrites was confirmed. Cl : Br ratios (g/g) ranged from 46 to 6700. Primordial halogen abundance ratios (by numbers of atoms) were estimated to be: Cl : Br ≅ 390, Br : I ≅ 13. The Murray carbonaceous chondrite was found to be exceptional in its halogen abundances. These and other abundance anomalies (e.g. those in the Hvittis enstatite chondrite) suggest a complex history of halogen fractionations in meteorites, perhaps involving multiple mechanisms. (auth) (UK)

22 PRECIOUS METAL ABUNDANCES IN SOME CARBONACEOUS AND ENSTATITE CHONDRITES. Crocket, J. H.; Keays, R. R.; Hsieh, S. (McMaster Univ., Hamilton, Ont.). Geochim. Cosmochim. Acta, 31: 1615-23(Oct. 1967).

The data are compared with previously published precious metal values for olivine bronzite and olivine hypersthene chondrites. Abundances in olivine bronzite and carbonaceous chondrites were generally comparable, except for Ir, which was lower in the former group. Both the enstatite and olivine hypersthene chondrites had lower atomic abundances than the carbonaceous chondrites, except for Au in the enstatite chondrites. The average depletion of precious metals in the olivine hypersthene chondrites relative to the carbonaceous chondrites was approximately 40%. As no obvious mechanisms for fractionation of precious metals during condensation of meteoritic matter were apparent, their abundances in carbonaceous chondrites should provide good estimates of the cosmic abundances of these elements. (auth) (UK)

23 DIRECT COMPLEXOMETRIC DETERMINATION OF ZIRCONIUM(IV) IN RELATION TO POLYMERISATION. Sinha, B. C.; Das Gupta, S. (Central Glass and Ceramic Research Inst., Calcutta). Analyst, 92: 558-64(Sept. 1967).

Polymerization and de-polymerization of zirconium on boiling and aging in various concentrations of nitric, hydrochloric, and sulfuric acids were systematically studied and the optimum experimental conditions for complete de-polymerization and titration of zirconium ions worked out. A simple and accurate method is described for the direct titration of zirconium ions with EDTA. Most of the elements, other than phosphorus and fluorine do not interfere. The method was successfully used for determining zirconium in zircon and commercial zirconium dioxide. (auth)

24 APPLICATION OF AN ANALOG COMPUTER TO THE RADIOCHEMICAL DETERMINATION OF BURN-UP IN HIGHLY ENRICHED FUEL ELEMENTS. Marangio, G. (CSN, Casaccia, Rome); Pugnetti, G.; Rimini, B. Energ. Nucl. (Milan), 14: 665-8(Nov. 1967).

In order to determine the burnup by standard radiochemical procedures of MTR fuel plates irradiated to a high burnup a suitable calculation was developed through an analog computer. For the computation well-known equations representing fuel burnup and fission-product buildup were used. The values of both the neutron thermal flux and the initial fuel concentration were parametrically changed in the analog computation in order to obtain the final concentration of uranium, ^{137}Cs, and ^{144}Ce, as experimentally determined. The burnup expressed as atoms fissioned per cent of the initial uranium atoms was 22.3 ± 5%. (M.C.G.)

25 QUANTITATIVE DETERMINATION OF EVAPORATED Si FILMS BY NEUTRON ACTIVATION. Peart, R. F.; Jona, F.; Wendt, H. R.; Seirmarco, J. A. (IBM Watson Research Center, Yorktown Heights, N. Y.). J. Appl. Phys., 38: 4927-8(Nov. 1967).

A method for the quantitative determination of very small deposits of silicon is described that relies upon radioisotope analysis following neutron activation of the material deposited. The present results provide quantitative proof that the neutron activation method is efficient and accurate for the determination of Si amounts corresponding to equivalent coverages of the order of one atomic layer. (M.H.R.)

26 HOT EXTRACTION METHOD FOR HYDROGEN ANALYSES OF ZIRCONIUM AND ZIRCONIUM ALLOYS USING CRYOGENIC PUMPING. Gulbransen, Earl A.; Andrew, Kenneth F. (Westinghouse Electric Corp., Pittsburgh). Electrochem. Technol., 5: 471-2(Sep.-Oct. 1967).

The method was designed to use samples of 0.01 to 0.2g and to determine hydrogen contents of zirconium and zirconium alloys with a sensitivity of 10^{-7}g or 1 ppM on a 0.1-g sample. Hydrogen was extracted by heating the sample to 1200°C and condensed into a liquid helium-cooled trap. The hydrogen was then vaporized into a known volume and the pressure measured by a sensitive capacity manometer. Hydrogen analyses are given on standardized Zircaloy-2 samples and on Zircaloy-2 after oxidation in a water vapor environment. (auth)

27 GAMMA ACTIVATION ANALYSIS: A REVIEW. Baker, C. A. (Atomic Energy Research Establishment, Harwell, Eng.). Analyst, 92: 601-10(Oct. 1967).

Gamma activation analysis was applied to determinations of the light elements C, N, and O, whose nuclear properties are unfavorable for neutron activation. Because of their penetrating nature, gamma photons share with neutrons the advantages of homogeneous activation and post-irradiation etching, that are of particular value when investigating the metallurgical properties of high purity materials. A review is given of the whole field of gamma activation analysis under the following headings: Types of gamma activation ((γ,γ) activation; Moessbauer effect; (γ − γ′) activation; (γ,n) activation in which neutrons are detected; (γ,n) reactions in which the product nucleus is measured; (γ,2n), (γ,p), (γ,pn), and (γ,αn) reactions); nuclear considerations for (γ,n) reactions (sources of high energy photons, cyclic machines, linear machines); nature of product nuclides (characterization of radiations, standards); determination of the light elements oxygen, nitrogen, carbon, and fluorine; use of spectrometry and other instrumental methods; destructive analysis by rapid chemical separation (rapid separations of radiochemically pure oxygen, chemical separation of carbon activity); and determination of heavier elements (atomic number equal to or greater than 10). Intrinsic sensitivity of gamma activation analysis is discussed in the appendix. (22 references.) (UK)

29 DETERMINATION OF NITRITE ION USING THE REACTION WITH ρ-NITROANILINE AND AZULENE. Garcia, E. E. (General Electric Co., Pleasanton, Calif.). Anal. Chem., 39: 1605-7(Nov. 1967).

A sensitive, rapid method for the determination of nitrite ion is described. Nitrite was reacted with ρ-nitroaniline to form a diazonium ion, which was then coupled with azulene to form a purplish pink azo dye. Absorbance of the dye was measured at 515 mμ. Diazotization and coupling were very fast and no controls of pH and temperature were necessary. The sensitivity of the method (expressed as the amount of nitrite corresponding to an absorbance of 0.010 at 515 mμ in a 1-cm cell) was 0.22 μg of nitrite. The molar absorptivity was 5.2×10^4 mole^{-1} cm^{-1} liter. The precision was also satisfactory; the relative standard deviation at the 10-μg level was ±1.6%. The procedure's simplicity permitted its use in remote analyses of highly radioactive solutions. Iron(III) was the only ion tested that interfered seriously. Large amounts of nitrate and nitric acid did not interfere. (auth)

30 A NEW RADIOMETRIC STUDY OF THE SEPARATION AND ESTIMATION OF TRACES OF YTTRIUM. Kar, K. R.; Jain, S. C. (Univ. of Delhi). Curr. Sci. (India), 36: 542-3 (Oct. 20, 1967).

Results of an investigation of a radiometric method of estimating yttrium in trace amounts is reported. The method involves quantitative precipitation of the trace element as its phosphate of known stoichiometry and radiometric estimation of the amount of phosphorus removed as yttrium phosphate from the reaction mixture. If the correct stoichiometric ratio, Y : P, in the precipitate and also the amount of phosphorus present in it are known, the quantity of yttrium is easily calculated. Results show that as small as 4 μg of the element can be estimated with a fair degree of accuracy. A single estimation can be carried out in less than two hours. (D.H.M.)

31 DETERMINATION OF COMBINED NITROGEN IN TUNGSTEN METAL POWDER. Awasthi, S. P.; Sahasranaman, S.; Sundaresan, M. (Bhabha Atomic Research Centre, Trombay, India). Analyst, 92: 650-2(Oct. 1967).

A method for the determination of combined nitrogen in tungsten metal powder, based on the dissolution of the sample in 30 per cent wt/vol hydrogen peroxide, hydrolysis of the nitrides, and the fixation of nitrogen as ammonium salts in concentrated hydrochloric acid, has been developed. The coefficient of variation was determined to be ±5.3 per cent at the 75 ppM and ±8 per cent at the 30 ppM level. (auth) (UK)

32 DETERMINATION OF HYDROGEN FLUORIDE AND URANIUM(VI) IN CRUDE URANIUM HEXAFLUORIDE BY HYDROLYSIS AND POTENTIOMETRIC TITRATION. Shinohara, Haruka; Izawa, Kimie; Tsujimura, Shigeo; Motojima, Kenji (Japan Atomic Energy Research Inst., Ibaraki). J. Nucl. Sci. Technol. (Tokyo), 4: 482-7(Sept. 1967).

A simple method for determining HF and U(VI) in a hydrolyzed solution of UF_6 by alkalimetry is described. About 1 g of UF_6 was taken in a polytrifluoromonochloroethylene tube, and hydrolyzed with about 50 ml of water in a closed polyethylene bottle. Using a glass electrode, HF in the hydrolyzed solution was titrated potentiometrically with an alkali solution, after the U(VI) was masked with ammonium sulfate. When the equivalence point for the free acid was reached, hydrogen peroxide was added to the solution and the liberated acid equivalent to U(VI) was titrated with the same standard alkali solution. Assuming that the hydrolysis of UF_6 takes place stoichiometrically, the accuracy of this method was roughly evaluated to be ±10% for the ratio of HF/UF_6 and ±1% for the value of U(VI) in the range of 0 to 1 mole of HF per mole of UF_6. (auth)

33 RADIATION CHEMICAL STUDIES WITH HEAVY ION RADIATIONS. Schuler, Robert H. (Mellon Inst., Pittsburgh. Yale Univ., New Haven). J. Phys. Chem., 71: 3712-13(Oct. 67)

mercury electrode. Two of the three Kalousek techniques were examined for applicability as analytical methods. The Kalousek current was proportional to concentration for a given reversible species, and the ratio of the Kalousek to the diffusion-limited current provides an immediate qualitative measure of the kinetics of the reoxidation process. The reproducibility and analytical range is essentially equivalent to that reported for square-wave polarography, with the added advantage that reversible systems can be determined in the presence of hydronium ion discharge. Demonstrated analytical applications are based on the capability of Kalousek polarography to distinguish readily between reversible and irreversible reactions at the DME. (auth)

35 DETERMINATION OF GADOLINIUM AND EUROPIUM IN THEIR TUNGSTEN BRONZES BY HIGH ENERGY PHOTON ACTIVATION AND COMPUTER RESOLUTION OF GAMMA-RAY SPECTRA. Korthoven, Peter J. M.; Wechter, Margaret A.; Voigt, Adolf F. (Ames Lab., Iowa). Anal. Chem., 39: 1594-8 (Nov. 1967). (IS-1608).

The method of nondestructive activation analysis was applied to the determination of gadolinium and europium in their tungsten bronzes. Synchrotron bremsstrahlung was used to produce the reactions $^{160}Gd(\gamma,n)^{159}Gd$, $^{153}Eu(\gamma,n)^{152}Eu$, $^{186}W(\gamma,p)^{185}Ta$, and $^{186}W(\gamma,pn)^{184}Ta$, and the ratio of rare earth to tungsten activities was compared to that found in samples of known composition. A linear least-squares fitting program was used for analysis of the γ scintillation spectra. This program requires information about all components present in the spectrum after irradiation. A component need not be a single isotope, but may be a mixture of several, so long as sample and standard are counted at exactly the same time after irradiation and identical irradiation and counting times are used. The sample spectrum is assumed to be a linear combination of the component spectra. The program allows coarse and fine gain adjustments to be made, the latter by an iterative procedure in which a direct search method is applied. (auth)

36 SPECTROPHOTOMETRIC DETERMINATION OF IRON WITH 2,4-DIHYDROXYPROPIOPHENONE OXIME. Gandhi, M. H.; Desai, Mahendra N. (Gujarat Univ., Ahmedabad, India). Anal. Chem., 39: 1643-4(Nov. 1967).

The use of 2,4-dihydroxypropiophenone oxime in the spectrophotometric determination of iron was investigated. Optimum pH for the complex formation was 2.6 to 2.8. The reagent is highly specific and can be used to determine small quantities of iron in the presence of many cations. The absorbance values of the complex are practically constant in the spectral range 500 to 520 mμ giving rise to a 20 mμ wide plateau that permits the use of this reagent in filter photometers. The sensitivity of the reaction as defined by Sandell was 0.056 μg/cm^2. (D.H.M.)

37 DETERMINING THE TRUE MID-POINT OF A COUNT RATE OBSERVED IN RADIONUCLEAR COUNTING. Gordus, Adon A. (Univ. of Michigan, Ann Arbor). Anal. Chem., 39: 1672 (Nov. 1967).

A derivation of a factor to help determine the conditions under which it is necessary to incorporate factors given by Hoffman and Van Camerik for calculating the time of day that should be recorded as representative of the experimentally observed counting rate of a radioactive sample is presented. (D.H.M.)

38 ISOTOPE ANALYSIS OF HELIUM BY SPECTROMETRY WITH THE AID OF AN ISOTOPIC FILTER. L'vov, B. V.; Mosichev, V. I. (State Inst. of Applied Chemistry, Leningrad). Isotopenpraxis, 3: 322-4(1967). (In Russian).

A simple photoelectric method for isotope analysis of helium (^{3}He–^{4}He) is described based on measuring the emission of the He line 10830 Å components ($2^3P_{0,1,2}$–2^3S_1) corresponding to the isotope ^{3}He only. These components were separated from the total emission by using a special isotope filter consisting mainly of an absorption tube filled with natural helium, in which a glow discharge was sustained. The calibration curve for the range of 0 to 100% investigated was 2-shaped in good agreement with the theoretical curve. (auth)

39 RADIOACTIVITY ASSAY AND SPECIFIC ACTIVITY DETERMINATION OF METALLIC CARBONATES–^{14}C BY THE FLOW MONITORING COUNTER. Barakat, M. F.; Zahran, A. H. (Atomic Energy Establishment, Cairo). Isotopenpraxis, 3: 325-7(1967).

A simple and accurate technique is described for the standardization of different metallic carbonates tagged with ^{14}C based on liberation of radioactive carbon dioxide by the action of concentrated sulfuric acid followed by the continuous monitoring of the carbon dioxide in the stream of carrier gas by a flow monitoring Geiger counter. Results showed that the technique could be applied successfully and with good reproducibility for samples with specific

activities as low as fractions of a millimicrocurie per milligram labeled carbonate and that it is much more reliable than other techniques usually applied. (auth)

40 MATERIAL STUDIES BASED ON THE ELASTIC SCATTERING OF HARD GAMMA-RAYS. Dahn, E. (Institut fuer Angewandte Radioaktivitaet, Leipzig). Isotopenpraxis, 3: 309-13(1967). (In German).

Studies were carried out on utilizing elastic scattering of hard γ rays for determination of the content of constituents in binary systems. The elastic scattering phenomenon dominant in the quantum energy range of about 1 MeV, Rayleigh scattering, is strongly dependent on Z. On the other hand, the cross section attains values sufficiently high in practical use but for small angles of scattering ($\lesssim 10°$). Separation from Compton scattering seems to be impossible in this range when a scintillation detector is used. It is shown that a dependence on atomic number Z higher than by a square law can also be obtained in measuring the summary cross section (elastic + inelastic). The measurements were carried out with ^{203}Hg (Eγ = 279 keV) or ^{137}Cs (Eγ = 661 keV). Using the harder radiation of ^{137}Cs is essentially advantageous in comparison with the softer radiation of ^{203}Hg in spite of the more difficult execution of the experiments. (auth)

41 ACTIVATION ANALYSIS OF BROMINE BY 14-MeV NEUTRONS IN ACTIVABLE TRACER STUDY OF RIVER FLOW. Nagatsuka, Sumiko (Tokyo Metropolitan Isotope Research Center); Suzuki, Hamaji; Nakajima, Kiyoshi; Kobayashi, Masatoshi. Radioisotopes (Tokyo), 16: 505-8(Oct. 1967).

The activation analysis using 14-MeV neutrons of river water for bromine was examined for use of bromine as an activable tracer to study the flow of river water, since use of the neutron generators is easier than the use of reactors. The detection sensitivity for bromine was limited to 1 ppM by the presence of ^{13}N produced from oxygen. This corresponds to a dilution rate of about 10^6 if the concentration of tracer solution is 2.81 kg/10l NH_4Br and the volume of the water sample is 100 ml. (auth)

42 DETERMINATION OF SELENIUM AND TELLURIUM IN SILVER CHLORIDE AND URANIUM OXIDE. Russell, B. G.; Lubbe, W. V.; Wilson, Anita; Jones, Elaine; Taylor, J. D.; Steele, T. W. (National Inst. for Metallurgy, Johannesburg). Talanta, 14: 957-66(Aug. 1967).

Methods are described for the determination of selenium and tellurium in crude silver chloride produced as a by-product of the refining of gold, and in high-purity uranium oxide. Selenium and tellurium are separated from one another, as well as from the numerous other substances in the sample, before they are extracted into organic solvents and determined spectrophotometrically. For the spectrophotometric determination of selenium, 3,3'-diaminobenzidine is used, and for tellurium, symdiphenylthiourea. A minimum of 2 ppM of each element may be determined in silver chloride of 0.3 ppM in uranium oxide. Statistical data are given to show the precision and accuracy of the methods. (auth) (UK)

43 APPLICATION OF THE GROUP METHOD IN THE ANALYSIS OF EXPERIMENTAL DECAY CURVES. Rakovic, M.; Prouza, Z. (Charles Univ., Prague). Atompraxis, 13: 361-2(Aug. 1967).

A mathematical procedure is given for the analysis of the complex decay curves based on the group method, considering the individual experimental points as approximately accurate values. The accuracy of the determination of individual components is estimated. (auth)

44 DETERMINATION OF BORON CONTENT IN SEVERAL MEDIUMS BY PROMPT GAMMA RAY ANALYSIS. Furukawa, Yoshinori; Koyama, Masaki; Yuki, Makoto (Musashi Inst. of Tech., Japan). Radioisotopes (Tokyo), 16: 499-503(Oct. 1967).

Detection of boron in various media (water, carbon, glass, and Al powder) was investigated quantitatively by prompt γ-analysis techniques using a NaI(Tl) scintillation detector and Ge solid-state detector. Gamma rays from the reaction $^{10}B(n,\alpha)^{7m}Li$, $^{7m}Li \rightarrow {}^{7}Li$ + 477 keV were produced as prompt gamma rays using the collimated neutron beam from the TRIGA-II reactor as the neutron source. The limits of detection (sensitivity and accuracy) were examined and counting efficiencies, S/N ratios, and resolutions of 3 kinds of detectors were compared. The method of background treatment at the reactor site was studied and discussed. (auth)

45 RADIOACTIVATION ANALYSIS OF BROMINE IN HUMAN CEREBROSPINAL FLUID. Yanagisawa, Isamu (Toho Univ., Tokyo); Yoshikawa, Haruhisa. Radioisotopes (Tokyo), 16: 554-5(Oct. 1967).

Neutron activation analysis and paper chromatography were used to determine the amount of bromine in human cerebrospinal fluid (CSF). It was necessary to remove sodium before radioactivation since it is activated by neutrons in the same order as bromine. The total bromine content in CSF was found to be about 7 mg/100 ml, which is in good agreement with the average normal value obtained by chemical methods. (D.H.M.)

46 RADIOACTIVATION ANALYSIS OF COPPER IN GALLIUM ARSENIDE AS SEMICONDUCTOR MATERIAL. Kudo, Kiyoshi; Araki, Hidemaro; Fujimoto, Masatomo; Sato, Yasuo (Nippon Telegraph and Telephone Public Corp., Tokyo). Radioisotopes (Tokyo), 16: 549-50(Oct. 1967).

The copper content in gallium arsenide wafers was determined by activation analysis based on quantitative isotopic dilution principles. A wafer of gallium arsenide was cut from the ingot using a cutter made of diamond or silicon carbide. Some of the wafers were put in quartz ampoules and sealed off under vacuum, then heated in a furnace at 900°C for 5 hr. Others were similarly heated under hydrogen. The samples were irradiated in the nuclear reactor JRR-1 for 5 hr or JRR-2 for 2 min and extractions were performed using dithizone. The copper contents in unheated gallium arsenide wafers were 0.02 to 0.2 ppM. This indicates that no contamination of copper occurred during the process of diamond cutting. The copper content was equal in different gallium arsenide ingots; however, the copper content was increased by heat treatments and fluctuating values were obtained. (D.H.M.)

47 ACTIVATION ANALYSIS OF CANCEROUS TISSUE. (PART 1). Higashi, Tomomitu (Kanagawa Dental Coll., Japan); Hisada, Taro; Ikemoto, Sinichi; Tomura, Kenji; Nagahara, Teruaki. Radioisotopes (Tokyo), 16: 543-8(Oct. 1967). (In Japanese).

Activation analysis was used to determine whether cancerous tissue contained characteristic inorganic trace elements. The first experiment was not successful, since the abundantly produced ^{24}Na in the tissue interfered with the satisfactory detection of other inorganic elements. For the second trial, the anticoincidence NaI(Tl) spectrometer was used to measure the quantitative K/Na ratio for the normal and cancerous tissues, but no significant results were obtained. For the third trial, a microautoradiograph technique was applied to the cancerous tissues obtained from various sources such as the stomach, breast, thyroid gland, and intestine. The third experiment was successful in demonstrating the localization of the granules that indicate the presence of ^{32}P in the tissue. The granules were identifiable particularly in the regions of the nuclear membrane, nucleus, chromatins, and plasma membrane. (auth)

48 DETERMINATION OF ARSENIC IN BIOLOGICAL MATERIALS BY ACTIVATION ANALYSIS. Kimura, Yuichiro (Kinki Univ., Japan); Morishima, Hiroshige; Koga, Taeko; Honda, Yoshihide; Kawai, Hiroshi; Kimura, Kozaburo; Miyaguchi, Yoichiro; Nishiwaki, Yasushi. Radioisotopes (Tokyo), 16: 537-42(Oct. 1967). (In Japanese).

The modified Gutzeit method for separation of arsenic was combined with neutron activation analysis of arsenic in biological materials. The samples were first irradiated with thermal neutrons at a flux of about 4×10^{12} n/cm²/sec for 1 hour and then digested with nitric–sulfuric acid. Activated arsenic as arsine evolved by modified Gutzeit method was collected on a mercuric bromide paper strip and then the radioactivity was measured. The minimum detectable amount of activated arsenic on the mercuric bromide paper strip in this method was of the order of 10^{-3} μg and the mean recovery was about 80% with the standard deviation of less than 10%. Quantitative determination of arsenic in human hair was attempted with this method. (auth)

49 STUDIES ON THE NEUTRON ACTIVATION ANALYSIS OF INORGANIC MINOR ELEMENTS IN PLANTS AND SOILS. NONDESTRUCTIVE METHOD OF THE BROMINE DETERMINATION IN PLANT MATERIALS BY ^{82}Br. Shibuya, Masao (National Inst. of Agricultural Sciences, Japan); Yuita, Kouichi; Suzuki, Kiyoshi. Radioisotopes (Tokyo), 16: 531-6(Oct. 1967). (In Japanese).

To establish a routine method of activation analysis for bromine in the plant materials, the nondestructive method was studied and samples of plant materials of widely different bromine content were analyzed by nondestructive neutron activation analysis. According to the differences of neutron cross section, the decay constant, and the content of the elements in question, the time required for neutron irradiation and cooling time were selected. In this method, 50 to 300 mg of plant materials were enclosed in small polyethylene bag for irradiation. The samples and Br standard were then irradiated in a capsule in the JRR-1 reactor at a flux of

3×10^{11} n/cm²/sec for a period of 5 hours (or JRR-2 reactor at a flux of 8×10^{13} n/cm²/sec for a period of 5 minutes). After a cooling time of 50 hours, the activity of the ^{82}Br was measured, using photopeak of γ rays of 0.77 MeV by a multichannel pulse-height analyzer. Precision ranges from ±3% (standard deviation) for samples with high bromine contents to ±20% for samples with low contents. This method can be applicable to the sample containing bromine as low as 0.15 ppM. (auth)

50 RADIOACTIVATION ANALYSIS OF TRACE ELEMENTS IN RICE PLANT. DETERMINATIONS OF MANGANESE, MAGNESIUM, SODIUM, POTASSIUM, CHLORINE, BROMINE, COPPER, AND ZINC. Kusaka, Yuzuru (Konan Univ., Kobe, Japan); Chen, Ping-yao; Tsuji, Haruo; Imai, Sakingo. Radioisotopes (Tokyo), 16: 526-30(Oct. 1967). (In Japanese).

Neutron activation analysis was applied to elucidate the distribution of several trace elements in rice plants. The seed, stem, leaf, chaff, and grain samples (1 g each) were irradiated for 5 or 30 min using the Tsing Hua University Reactor or the Kyoto University Reactor (swimming-pool type, 1 MW, 2 to 4×10^{12} thermal neutrons/cm²/sec). After irradiation, manganese, sodium, and potassium could be determined non-destructively without any chemical treatment. Chlorine, bromine, copper, and zinc were determined after some radiochemical separation treatments. The induced radioactivities in the non-separated and the separated specimens were measured by the γ-ray spectrometries, using a TMC 100-channel analyzer with a 2 in. × 2 in. NaI scintillator or a RCL 512-channel analyzer with a 3 in. × 3 in. NaI scintillator. In the potassium determination, a spectrum-stripping method to eliminate sodium interference was applied. In the destructive method, irradiated samples were decomposed with mixtures of conc.H_2SO_4 and conc.HNO_3. Chlorine and bromine were determined in the acidic distillates through silver salt precipitations, and copper and zinc in the residual solutions through chloride anion exchange and oxine salt precipitations. All the chemical yields were more than 95%. The experimental errors were 3 to 5% in the manganese, 5 to 10% in the sodium, the potassium, the chlorine, the bromine and the copper, and 10 to 20% in the zinc analyses. The experimental results showed that chlorine tends to be concentrated in the seed, manganese, sodium, and bromine in the leaf, and potassium in the stem. These distribution effects may reflect the metabolic specificity in the organ of the rice plant. (auth)

51 THE DETERMINATION OF OXYGEN AND SULFUR IN PETROLEUM PRODUCTS BY FAST-NEUTRON ACTIVATION ANALYSIS. Tamura, Mitsuhisa; Yamaki, Naoomi (Resources Research Inst., Japan). Radioisotopes (Tokyo), 16: 519-25 (Oct. 1967). (In Japanese).

Analytical methods using 14-MeV neutrons for the determination of oxygen and sulfur in petroleum products and the permeability of polyethylene sample containers to various hydrocarbons are discussed. It is proposed that for the determination of oxygen in petroleum products a change in density may have an effect on self-shielding against neutrons and against the radiation from ^{16}N. On the basis of this proposal, it is estimated that the difference between the gradients of the calibration curves applied to gasoline and heavy fuel oil or lubricating oil is about 8%. The relative standard deviation on a result is about 10% at 100% ppM of oxygen. The rapid determination of sulfur is based on scintillation counting of the radiation from the 12.4 second ^{34}P produced by the ^{34}S(n,p)^{34}P reaction, requiring corrections for oxygen as a main interfering element. The relative error is about 4% at the range of 0.5 to 3% sulfur but the values obtained are 5 to 10% higher than those by bomb method because of impurities other than oxygen. Experimental time for an analysis is about 5 minutes. (auth)

52 RADIOACTIVATION ANALYSIS OF CADMIUM BASED ON THE QUANTITATIVE ISOTOPE DILUTION PRINCIPLE. Kudo, Kiyoshi (Nippon Telegraph and Telephone Public Corp., Tokyo); Yamamoto, Katsumi; Kuriyama, Shigeo. Radioisotopes (Tokyo), 16: 514-18(Oct. 1967).

A method of radioactivation analysis based on quantitative isotope dilution was developed for determination of traces of cadmium. The reaction between cadmium and dithizone was carried out at various conditions and the reaction ratio was constant in a solution of 1N sodium hydroxide containing more than 200 μg of cadmium carrier. It was also shown that the radioactivity of the extract was proportional to the amount of cadmium isotope. The method was applied to determination of cadmium in aluminum and in zinc. After neutron irradiation, a large amount of cadmium carrier was added and separated by the two dithizone extraction steps. The second extraction was carried out with dithizone in a smaller amount than that required to react with cadmium present and the radioactivity of the extract (a) was measured. A cadmium standard (M_s) was treated in exactly the same way as a test sample and the radioactivity (a_s) was measured. The unknown amount of cadmium (M_x) was calculated from $M_x = M_s\, a/a_s$; 0.3 ppM of cadmium was determined in zinc sample. (auth)

53 ACTIVATION ANALYSIS OF OXYGEN IN ALUMINIUM BY USING α AND ^{3}He PARTICLES. Sawai, Teruko (Tokyo Metropolitan Isotope Research Center); Albert, Philippe. Radioisotopes (Tokyo), 16: 509-13(Oct. 1967). (In Japanese).

The nondestructive activation analysis of Al for O_2 was carried out by means of ^{16}O(α,pn)^{18}F, ^{16}O(α,d)^{18}F, ^{16}O(α,2n)^{18}Ne $\xrightarrow{\beta^+}$ ^{18}F, ^{16}O(^{3}He,n)^{18}F, and ^{16}O(^{3}He,p)^{18}Ne $\xrightarrow{\beta^+}$ ^{18}F reactions. The equivalent thickness method proposed by C. Engelmann, that is much simpler than the absolute method was used to calculate the content. Possible interfering nuclear reactions of aluminium and its impurities were examined. The analytical sensitivity in α- and ^{3}He-activation was very high and the half-life of ^{18}F was long enough to eliminate surface contamination and oxide films. The detection limits were compared with those for the ^{16}O(γ,n)^{15}O and ^{16}O(n,p)^{16}N reactions. Activation analysis by ^{3}He was found to be the best method for determination of O_2 in Al. (auth)

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Refer also to abstracts 98, 110, 119, 140, 214, and 1349.

54 (AD-646572) MICROWAVE ABSORPTION SPECTRUM OF MAGNETICALLY ORDERED DYSPROSIUM METAL. Rossol, Frederick Carl (Harvard Univ., Cambridge, Mass. Gordon McKay Lab. of Applied Science). Nov. 1966. Contract AF19 (628)-3874. 248p. (AFCRL-66-666). CFSTI.

The heavy rare earths all crystallize in a hexagonal close-packed structure and exhibit a tendency toward spatially periodic ordering of magnetic moments at low temperatures. An experimental study was made of the excited states in such magnetic systems for the various phases of ground-state ordering. Dysprosium was chosen because of the relative simplicity of its ground-state ordering and because of the abundance of experimental evidence concerning its static magnetic properties. Ferromagnetic resonance was observed at 37 Gc/sec by using the anisotropy in the hexagonal plane. The temperature dependence of the field for resonance gives a measure of the temperature dependence of the hexagonal anisotropy, which is in good agreement with the behavior estimated from static measurements of magnetization. The most striking feature of this resonance absorption is its extremely large width. Absorption measured at temperatures in the spiral range with the field applied along an easy axis in the hexagonal plane showed an abrupt increase corresponding to a sharp rise in permeability at the field required to induce ferromagnetic ordering. This abrupt change is followed at higher fields by a gradual fall-off of absorption consistent with the increasing separation of the resonant frequency above the experimental frequency at higher fields. (TAB)

55 (ANL-7352) ELECTRON-MICROSCOPIC STUDIES OF FUNDAMENTAL PHYSICAL AND CHEMICAL PROCESSES IN SINGLE CRYSTALS OF GRAPHITE. Montet, G.; Feates, F.; Myers, G. (Argonne National Lab., Ill.). June 1967. Contract W-31-109-eng-38. 49p. Dep. CFSTI.

Studies of processes occurring in single crystals of graphite as a result of certain physical and chemical changes used the etch-decoration technique for detection of defects in graphite by electron microscopy. Displacement energy in graphite, optical density and thickness of graphite lamellae, and reactions of gases with single crystals of graphite are discussed. (M.C.G.)

56 (BM-RI-7046) HEAT OF FORMATION OF HOLMIUM AND TERBIUM TRICHLORIDES. Stuve, J. M. (Bureau of Mines, Reno, Nev. Reno Metallurgy Research Center). Nov. 1967. 9p. Bureau of Mines Free.

The standard heats of formation (ΔH_f°) of holmium trichloride and terbium trichloride were measured by solution calorimetry. Heats of solution of holmium and terbium metals and their anhydrous chlorides were measured in 4.360 molal HCl at 298.15°K. From these measurements ΔH_f° for $HoCl_3$ (c) was calculated as −240,290 ±1,700 cal/mole, and ΔH_f° for $TbCl_3$ (c) was calculated as −238,330 ±1,500 cal/mole at 298.15°K. (auth)

57 (ORNL-4095) A SOL-GEL PROCESS FOR PREPARING ThO_2-UO_3 SOLS FROM NITRATE SOLUTIONS BY SOLVENT EXTRACTION WITH AMINES. Moore, John G. (Oak Ridge National Lab., Tenn.). Oct. 1967. Contract W-7405-eng-26. 44p. Dep. CFSTI.

A solvent extraction process using long-chain aliphatic amines was developed and demonstrated, on a laboratory scale, for preparing thoria sols and thorium–uranium oxide sols (containing up

to 58 mole % uranium) directly from aqueous thorium nitrate–uranyl nitrate solutions. About 80 to 90% of the nitrate was extracted by contacting the solution for at least 2 min with the amine, dissolved in an inert diluent. The aqueous phase was then separated from the organic phase and digested at least 10 min at 95 to 100°C. This converted the aqueous phase into a sol and released additional nitrate, which was extracted with the amine in a second stage. The equilibrium nitrate: metal mole ratio decreased linearly with uranium concentration from about 0.28 for pure thoria sols to about 0.16 for thorium–uranium sols containing more than 25 mole % uranium. Most of the sols were prepared with 0.6 to 0.75M Amberlite LA-2, an extensively branched commercial secondary amine (N-lauryl trialkylmethyl amine) in n-paraffin or n-dodecane. Approximately 1.2 to 1.5 moles of amine per mole of initial nitrate was used to extract the nitrate. The extractions were made with the organic phase continuous at 50 to 60°C to ensure rapid phase separations. The dilute sol may be dried to gel fragments or evaporated to a concentration of 1 to 2M in total metal oxide and then formed into gel microspheres. The resulting fragments or spheres are dried, calcined in air at 1150°C, and finally reduced with Ar–4% H_2. Gram quantities of ceramic spheres with compositions that are currently of interest as reactor fuels were made, starting with thorium nitrate solutions that contained 17 to 26 mole % uranyl nitrate. Most of these spheres had densities greater than 95% of the theoretical densities of the oxide solid solutions, less than 1% porosity, and oxygen: uranium ratios of less than 2.01. Spheres 150 to 408 μ in diameter resisted crushing loads of 500 to greater than 2000 g. Engineering studies of this process are now being made, using equipment that is capable of producing up to 20 kg of the mixed oxide per day. (auth)

58 (UCRL–50200) THERMODYNAMIC STABILITY CONSTANTS OF ORGANIC/METAL–ION COMPLEXES. Fultz, Esther D. (California Univ., Livermore. Lawrence Radiation Lab.). Feb. 20, 1967. Contract W-7405-eng-48. 63p. Dep. CFSTI.

Values of the formation constants of organic metal-ion complexes were compiled from experimental data appearing in the literature up to the end of 1966. Tables of these thermodynamic stability constants constitute the main section of this report. Some conclusions regarding the preference of metal ions for various donor atoms of the ligand, and the effect of chelation on the stability of the complex are also presented. (auth)

59 (UJV–1783) VYPAROVANI AKTINIDU A JEJICH SLOUCENIN. III. VYPAROVANI NEKTERYCH SLOUCENIN URANU. (Vaporization of Various Actinide Compounds. III. Vaporization of Certain Uranium Compounds). Krivy, I. (Ceskoslovenska Akademie Ved, Rez. Ustav Jaderneho Vyzkumu). Mar. 1967. 48p. (In Czech). Dep.

The vaporization of some binary compounds of uranium, namely oxides, sulfides, nitrides, phosphides, carbides, silicides, germanides, borides, and intermediate compounds of uranium with Bi, Sn, Pb, Ga, In, and Zn is discussed. A survey and the critical evaluation of all available papers in the field up to the end of the first half of the past year is included, particular attention being paid to the compounds of interest in nuclear reactor technology. For each two-component system (e.g. oxides, carbides, etc.) fundamental data are given on: crystal structures, composition of the vapor over the condensed phases (at least qualitatively) together with the dependence on the experimental conditions; and, the results of tensimetric experiments usually given in the form $\log P = f(T)$. The values of dissociation energy for the gaseous species or those of standard free energy of formation for the individual condensed phases (ΔG_f°) are presented provided that they are derived on the basis of tensimetric data. (92 references). (auth)

60 (TT–65-50400/4-6) BULLETIN OF THE CHEMICAL SOCIETY, BELGRADE. Translation of Glas. Hem. Drus., Beograd, 30: 141-216(1965). 70p. CFSTI.

Research progress is reviewed under the following headings: short-wave end of the solar spectrum, vapor pressure of neon and argon, differences between ground levels of energies in vapor and liquid state of monatomic elements, polarographic determination of lead in cadmium, coulometric determination of copper, decarboxylation of oxalacetic acid, spectrophotometric determination of vitamin K_3, sorption of vapors of organic solvents on activated charcoal and silica gel, and porous structure of the vanadium catalyst for oxidation of sulfur dioxide. A separate abstract was prepared for one section on the short-wave end of the solar spectrum. (M.C.G.)

For an abstract of the individual section see: 790.

61 ISOTOPE EFFECTS IN THE CHLORINATION OF NAPHTHALENE. de la Mare, P. B. D.; Lomas, J. S. (Bedford Coll., London). Rec. Trav. Chim., 86: 1082-8(Oct. 1967).

The chlorination of naphthalene showed an inverse deuterium isotope effect, the reaction of naphthalene being slower than that of octadeuteronaphthalene by a factor of 0.85. The product-forming stages are also subject to a deuterium isotope effect, which influences the partitioning between addition and substitution; the most direct interpretation of the results is that the values of k_H/k_D for the stages of proton loss are subject to a normal deuterium isotope effect, with $k_H/k_D > 1.4$. (auth)

62 SPECTROPHOTOMETRIC STUDIES ON FERRON AND THORIUM (IV)–FERRON CHELATE. Hseu, Tong-Ming; Chen, Li-Shu (National Taiwan Univ., Taipei, China). J. Chin. Chem. Soc. (Taiwan), 13: 150-65(Dec. 1966).

The ionization constants of ferron (7-iodo-8-hydroxyquinoline-5-sulfonic acid) and the interaction between Th(IV) and ferron were studied spectrophotometrically at 25°C and an ionic strength of 0.1. The ionization constants were found to be $pK_1 = 2.41 \pm 0.01$, $pK_2 = 7.10 \pm 0.01$. The Th(IV)-ferron chelate in aqueous solution of pH 5.0 exhibited a characteristic absorption maximum at 365 mμ. The composition of Th(IV)–ferron chelate was 1:4 mole ratio of Th(IV) ion and ferron, and the stability constant (log K_s) was 26.22 ± 0.16. (auth)

63 CHARACTERISTIC TEMPERATURES AND ENTROPIES OF SOME REFRACTORY THORIUM COMPOUNDS. Aronson, S.; Ingraham, A. (Brookhaven National Lab., Upton, N. Y.). J. Nucl. Mater., 24: 74-9(1967).

Characteristic temperatures for the compounds ThS, ThN, $ThC_{0.91}$, $ThP_{0.95}$, Th_3P_4, ThO_2, and ThB_6 were determined from x-ray diffraction measurements. The reduction of peak intensity with increasing temperature was measured from room temperature to 1000°C. The entropies of the compounds and the vibrational amplitudes of the atoms in the compounds were calculated from the data and are related to the results of other studies on these compounds. (auth)

64 CHEMICAL ASPECTS OF NITRIDE, PHOSPHIDE, AND SULPHIDE FUELS. Allbutt, M.; Dell, R. M. (Atomic Energy Research Establishment, Harwell, Eng.). J. Nucl. Mater., 24: 1-20(1967).

The results of an extended investigation into the chemistry of the nitrides, phosphides, and sulfides of uranium and the nitrides and sulfides of plutonium are presented. The topics reviewed include crystal chemistry, preparation and fabrication of the NaCl type phases, thermodynamic stability and stoichiometry, the formation of solid solutions, oxidation and hydrolysis, compatibility with metals, and chemical effects of irradiation. The comparative merits and limitations of these compounds as nuclear fuels are discussed from a chemical standpoint. (J.G.B.)

65 WILZBACH TRITIATION STUDIES. III. A STUDY OF PHYSICAL VARIABLES AFFECTING EXCHANGE IN THE POLYCYCLIC AROMATICS. Garnett, J. L.; Law, S. W. Aust. J. Chem., 20: 1875-85(Sept. 1967).

The effects of particle size of substrate and tritium gas pressure on the efficiency of Wilzbach tritiation of crystalline polycyclic hydrocarbons were investigated. The hydrocarbons studied included naphthalene, biphenyl, phenanthrene, chrysene, pyrene, m- and p-terphenyls, and acridine. No simple relationship between ionization potential and tritium incorporation was observed. The effects of radical scavengers such as nitric oxide and moderators such as helium on the labeling process were examined. Tritium incorporation in a polycyclic hydrocarbon was enhanced if gas exposure occurred in the presence of benzoic acid. The results are discussed in terms of current theories proposed for tritium labeling based on gas-phase studies. In the condensed phase present data show that radical processes are important in Wilzbach labeling. This was confirmed by a preliminary ESR examination of naphthalene and anthracene in the presence of tritium gas. (auth)

66 CRYSTAL STRUCTURE AND LATTICE PARAMETERS OF CURIUM TRICHLORIDE. Wallmann, J. C.; Fuger, J.; Peterson, J. R.; Green, J. L. (Univ. of California, Berkeley). Contract W-7405-eng-48. J. Inorg. Nucl. Chem., 29: 2745-51(Nov. 1967). (UCRL–16476).

$CmCl_3$ was found to exhibit the hexagonal UCl_3 structure. Powder data from two samples gave average lattice parameters $a = 7.380 \pm 0.006$ and $c = 4.186 \pm 0.010$ Å, where the error limits are the 95% confidence interval calculated using the standard statistical method for the average of two independent determinations. (auth) (UK)

67 DEUTERIUM ISOTOPE EFFECTS IN THE PHOTOCHEMISTRY OF A 20-OXOSTEROID ANALOGUE. Djerassi, C.; Zeeh, B. (Stanford Univ., Calif.). Chem. Ind. (London), No. 9, 358-9(Mar. 4, 1967).

Attempts have been made to compare photochemical and electron impact induced processes in a number of organic systems. One approach is an examination of the deuterium isotope effect in site-specific γ-hydrogen (or deuterium) migration. Photo-

elimination was studied in detail with 20-oxo-steroids, whose primary irradiation products are cyclobutanol and a ring D-opened ketone. The position of the double bond in the latter demonstrates that the photochemical hydrogen transfer originates from the angular methyl group. The electron impact induced decomposition of these steroids has also been investigated extensively, and the principal fragmentation pattern established. By analogy with the photochemical reaction it might be assumed that the migrating H-atom originates from the angular methyl group, followed by fission of the allylically activated bond. In actual fact labeling demonstrated that the migrating hydrogen originates from other positions, or that a strong isotope effect, discriminating against deuterium, is operating. A study of the course of photo-elimination in a deuterated 20-axo-steroid is described. (UK)

68 FURTHER STUDIES ON THE HOMOGENEOUS EXCHANGE REACTION H_2-D_2. Burcat, Alexander; Lifshitz, Assa (Hebrew Univ., Jerusalem). J. Chem. Phys., 47: 3079(1967).

Results of an investigation of the exchange reaction in HD strongly supports the "vibrational excitation" mechanism suggested previously for the homogeneous exchange reaction between hydrogen and deuterium in excess argon. Employing a single-pulse shock-tube technique, two series of experiments using two gas mixtures were carried out to determine the reaction order with respect to argon and the sum of the orders with respect to hydrogen and deuterium. The over-all reaction order was found to be approximately 2, but the sum of the orders $n_{D_2} + n_{H_2}$ was 1.3 ± 0.1. The activation energy was 40.1 kcal/mole. (D.H.M.)

69 PROPERTIES OF ACTIVE CENTERS IN THE PRECIPITATION OF RADIOACTIVE SUBSTANCES ON THE ANODE. Madi, Istvan. Magy. Fiz. Foly., 73: 283-8(June 1967). (In Hungarian).

Variability of equilibrium distribution coefficient of the precipitation of radioactive substances ^{204}Tl, ^{144}Ce, ^{212}Pb, and ^{54}Mn on the anode was studied as a function of the concentration of electrolyzed solution. It was found that in the electrolysis of solutions containing Tl^+ and Ce^{3+} ions the variability with the amount of precipitation on the anode can be described by the Langmuir isotherm. The variability with Mn^{2+} and Pb^{2+} precipitation on the anode cannot be described by the Langmuir equations because the precipitation of these ions results in formation of active centers on the anode. (tr-auth)

70 PRECIPITATION OF KINETICS OF RADIOACTIVE SUBSTANCES IN THE ANODE. Madi, Istvan. Magy. Fiz. Foly., 73: 274-82(June 1967). (In Hungarian).

Precipitation of radioactive ^{204}Tl on the anode was studied as a function of anode potential. The magnitude of the activation energy was determined as a function of the rate of precipitation of the radioactive substance on the anodes. It was found that the activation energy, in turn, depends on the anode potential and on the adsorption of the ions examined. The data on the kinetic measurements for various anode potentials showed that the magnitude of the equilibrium distribution coefficient ($\chi\infty/1 - \chi\infty$) varies inversely with the anode potential according to the curve peaks. The kinetics of anode separation of radioactive substances from various concentrations of ion solutions confirmed that the approximate rate constant magnitudes do not depend on the hydrogen ion concentration in the electrolyzed solution. (R.V.J.)

71 USES OF ISOTOPIC METHODS IN POLYMER CHEMISTRY. Bevington, J. C. (Univ. of Lancaster, Eng.). Chem. Ind. (London), No. 43, 1821-6(Oct. 28, 1967).

The uses of isotopic tracers in the study of reactions occurring during the formation of polymers are discussed. In this field both radioisotopes and enriched stable isotopes can be usefully employed on problems of many different types. Some examples are given. Most of the work described is in the nature of research. Some applications of high energy radiation to polymer chemistry are also briefly surveyed. (UK)

72 MEASUREMENT OF OXYGEN ACTIVITY IN IRON, IRON–SILICON, MANGANESE, AND IRON–MANGANESE MELTS USING SOLID ELECTROLYTE GALVANIC CELLS. Schwerdtfeger, Klaus (U. S. Steel Corp., Monroeville, Pa.). Trans. Met. Soc. AIME, 239: 1276-81(Sept. 1967).

In order to test the performance of $ZrO_2(CaO)$ and $ThO_2(Y_2O_3)$ electrolytes in the electrochemical determination of oxygen activities in liquid metals at steelmaking temperatures, electromotive force measurements were made with these cells: Fe–O(1)|$ZrO_2(CaO)$|air (1600°C); Fe–Si(1) + SiO_2(s)|$ZrO_2(CaO)$|air (1600°C); Mn(1) + MnO(s)|$ZrO_2(CaO)$|air (1290 to 1450°C); Mn(1) + MnO(s)|$ThO_2(Y_2O_3)$|Co–CO_2 (or H_2–CO_2 or air) (1260 to 1550°C); and Fe–Mn(1) + MnO(s)|$ThO_2(Y_2O_3)$|CO–CO_2 (1500°C). The oxygen activities are calculated from the electromotive forces for the investigated systems. The standard free energy of formation of MnO and the activity of manganese in Fe–Mn melts are derived. Indications are that the $ZrO_2(CaO)$ electrolyte exhibits little electronic conductivity at oxygen pressures as low as 10^{-12} atm at 1600°C; however, the partial electronic conductivity may become noticeable at lower oxygen activities. The $ThO_2(Y_2O_3)$ electrolyte is found to be an ionic conductor at the oxygen pressure as low as that for the Mn + MnO equilibrium, but exhibits partial electronic conductivity at oxygen pressures higher than 10^{-7} atm (1500°C). (auth)

73 THERMODYNAMIC PARAMETERS AND SOLVENT ISOTOPE EFFECTS AS MECHANISTIC CRITERIA IN THE NEUTRAL HYDROLYSIS OF SOME ALKYL TRIFLUOROACETATES IN WATER AND DEUTERIUM OXIDE. Martin, J. G.; Scott, J. M. W. (Memorial Univ. of Newfoundland, St. John's, Can.). Chem. Ind. (London), 16: 665(Apr. 22, 1967).

Thermodynamic parameters, rate constants, and solvent isotope effects (SIE) are indicated for CF_3CO_2R compounds (R = Me, Et, s-Pr, t-Bu) reacting in water and D_2O. A change of mechanism appears to occur in the hydrolysis of these esters, and the purpose of the study was to locate the point of mechanistic change. Differences in the thermodynamic parameters characterizing the activation process were very striking, and trends in solvent isotope effect with structure were equally striking. The first three esters in the above series gave SIE's ranging from 3.4 to 3.8, whereas the value for the t-Bu ester was 1.2. (UK)

74 SPIN-LATTICE RELAXATION IN SOLUTIONS OF ELECTROLYTES. I. RELAXATION OF ^7Li AND ^{23}Na IN AQUEOUS SOLUTIONS OF ALKALI HALIDES. Speight, P. A.; Armstrong, R. L. (Univ. of Toronto).* Can. J. Phys., 45: 2493-2503(Aug. 1967).

The concentration dependence of the relaxation rates of ^7Li and ^{23}Na ion nuclei in aqueous solutions of alkali halides was studied at 25°C, using a pulsed magnetic resonance spectrometer operating at 3.75 MHz. The data are represented by empirical equations of the form: $T_1^{-1} = T_{1^0}^{-1} + \gamma C^2$, where $T_{1^0}^{-1}$ is the infinite dilution relaxation rate and C is the solute molarity. The infinite dilution rates are discussed with reference to the theoretical model considered by Hertz (1961). The concentration dependence is analyzed by using an extension of the method introduced by Eisenstadt and Friedman (1966) to include terms quadratic in the solute concentration. (auth) (Canada)

75 SOLVENT EFFECTS IN ISOTOPE EXCHANGE REACTIONS. VIII. Koros, Endre; Orban, Miklos. Magy. Kem. Foly., 73: 266-9(June 1967). (In Hungarian).

The thermodynamic parameters of the exchange reaction between elementary iodine and 4-iodoantipyrine in different solvents were used to examine some extrathermodynamic relationships. It was concluded that the $\Delta H^{\ddagger}$ vs $T\Delta^{\ddagger}$ plots are linear, their slope is close to unity, and the isokinetical temperatures equal the experimental temperature (293K°); the $\Delta H_f^{\ddagger}$ vs $\Delta S_f^{\ddagger}$ plot is also linear, the isokinetical temperature is 310K°, in good agreement with the experimental value; the $\Delta H^{\ddagger}$ and $T\Delta S^{\ddagger}$ values increase with increasing polarity of the solvent. The $\Delta F^{\ddagger}$ values, however, remain about constant which indicates the validity of thermodynamic compensation ($\Delta H_f^{\ddagger} - T\Delta S^{\ddagger} \cong \Delta H_g^{\ddagger} - T\Delta S_g^{\ddagger}$). (auth)

76 SOLVENT EFFECTS IN ISOTOPE EXCHANGE REACTIONS. VII. Koros, Endre; Orban, Miklos. Magy. Kem. Foly., 73: 261-6(June 1967). (In Hungarian).

The probable mechanisms for the iodine exchange reactions between 4-iodoantipyrene (IAp) and I_2 in CS_2, C_6H_6, and aliphatic alcohols are suggested. The building-up and the structures of the activated complexes were investigated. It was concluded that the IAp–I_2 exchange reaction may be regarded as a process catalyzed by elementary iodine. This type of reaction has been named charge transfer autocatalysis. This concept was used to explain other iodine exchange reactions. (auth)

77 STUDY ON THE RATE AND THE PRODUCTS OF THE REACTION BETWEEN URANIUM MONOCARBIDE AND WATER. Hori, Yoshio; Mukaibo, Takashi (Tokyo Univ.). J. Nucl. Sci. Technol. (Tokyo), 4: 477-81(Sept. 1967).

With the use of a flow reactor, the products and the rate of reaction between UC powder and water were studied for the case of liquid water and water vapor under 20 to 100 mm Hg at 80°C and other temperatures. The oxide produced in the reaction with water vapor was determined to be UO_2 by chemical analysis. The reaction rate and the gaseous products were measured by means of a gas chromatograph. Neither the rate nor the products showed any marked difference between water and water vapor. This indicates that the two reaction proceed by a similar mechanism. As the temperature was raised further, the evolution of H_2, C_2H_6, C_3H_8, C_3H_6, etc. increased while that of CH_4 decreased. The rate of the evolution of gaseous products can be expressed in the form $R = \text{const.} \times \theta^n$, where θ is the coverage of water on the

carbide. The values of n were found to be 1.0 for CH_4, and 0.53 for H_2. Those for the C_2, C_3, and C_4 components were 1.0 for the high coverage region and less than unity for those of low coverage. This could be attributed to nonuniformity of the carbide surface. (auth)

78 THE EFFECT OF RARE GASES AND AROMATIC ADMIXTURES ON THE SELF-INDUCED ISOTOPIC EXCHANGE OF TRITIUM WITH TOLUENE. Ache, Hans J. (Virginia Polytechnic Inst., Blacksburg). J. Phys. Chem., 71: 3388-95(Oct. 1967).

The rate of the self-induced isotopic exchange of tritium with toluene vapor was found to be a function of the tritium concentration. Two reaction paths which lead to the labeling of toluene are discussed. They are the β decay-induced mechanism involving $(He^3T)^+$ and the radioinduced labeling in which ionized or excited toluene species and radicals react with T_2. The effects of rare gas additives and admixtures such as benzene and m-xylene on each of the two reaction mechanisms were studied separately. No effect on the decay-induced labeling was observed with helium and argon present, whereas the radioinduced mechanism was inhibited by these bases, probably due to the fact that β-radiation energy initially absorbed by the rare gas cannot be effectively transferred to the toluene to form reactive species which eventually react with T_2 to give tritiated toluene. In gaseous benzene–toluene mixtures, the labeling of one component was not affected by the presence of the other. It occurred strictly proportional to the electron fractions of the two compounds. (auth)

79 AUTOCATALYSIS AND DEUTERIUM ISOTOPE EFFECTS IN THE REACTION OF FORMIC ACID AND NITROGEN DIOXIDE. Barton, Donald; Yankwich, Peter E. (Univ. of Illinois, Urbana). Contract AT(11-1)-1142. J. Phys. Chem., 71: 3455-8(Oct. 1967). (COO-1142-73).

The rates of oxidation by nitrogen dioxide of the hydrogen isotopic formic acids (FA), HCOOH (hh), HCOOD (hd), DCOOH (dh), and DCOOD (dd) were measured in the centimeter range of partial pressures, at 191.3° in a Vycor vessel, with and without added nitric oxide. The rate law observed is of the form $-d(FA)/dt = k_1(FA)(NO_2) + B(NO)^{\frac{1}{2}}$, where B is an incompletely known function of (FA) and (NO_2). The finding that there is a small positive intercept on the rate axis when initial rate is plotted vs initial pressure of nitrogen dioxide suggests the possibility of a small deviation from the indicated simplicity of the nonautocatalytic term. Pollard and Holbrook reported an autocatalytic term of the form $k'(FA)(NO_2)(NO)$, but less than first-order dependence on nitric oxide can be seen in plots of some of their results. In experiments with added nitric oxide, a short induction period was observed. Isotope effects on k_1 and hh/hd = 1.39, hh/dh = 1.48, and hd/dd = 1.99; on B early in the reaction (all experiments at fixed initial pressures of FA and NO_2) they are hh/hd = 1.6_3, hh/dh + 1.5_1, and hh/dd = 2.2_8. The isotope effects are consistent with involvement of both formic acid hydrogens in rate-determining reactions. (auth)

80 ^{13}C KINETIC ISOTOPE EFFECT IN THE STRUCTURAL ISOMERIZATION OF CYCLOPROPANE: TEMPERATURE AND PRESSURE DEPENDENCE. Sims, L. B.; Yankwich, Peter E. (Univ. of Illinois, Urbana). Contract AT(11-1)-1142. J. Phys. Chem., 71: 3459-63(Oct. 1967). (COO-1142-74).

The ^{13}C kinetic isotope effect in the structural isomerization of cyclopropane to propylene was measured in the pressure range 1 to 760 mm at temperatures between 450 and 519°. The apparatus and procedure were proven by determinations of the first-order rate constant over the same ranges of experimental variables. Qualitatively, the ^{13}C isotope effect exhibited the same behavior as that due to deuterium labeling: at high pressures it was relatively pressure independent, but below about 100 mm it decreased approximately linearly with log p. At 1 atm, $k^{13}_{C_3H_4}/k^{13}_{C_2{}^{13}CH_4} = (0.995 \pm 0.001) \exp[(19.1 \pm 2.0)/RT]$. The ^{13}C effect is about 0.8% at 1 atm, falls to about 0.3% at 1 mm, and was surprisingly large for isotopy at only one carbon in the ring. The results indicate that the reaction coordinate involves considerable ring relaxation. (auth)

81 EQUILIBRIUM PRESSURES OF HYDROGEN DISSOLVED IN α-ZIRCONIUM. Ricca, Franco (Univ., Turin); Giorgi, Tiziano A. J. Phys. Chem., 71: 3627-31(Oct. 1967).

The pressures of gaseous hydrogen at equilibrium with hydrogen solutions in α-zirconium were measured in an ultrahigh-vacuum system, by using an omegatron mass spectrometer, over the temperature interval from 450 to 750° and for hydrogen-to-metal atom ratios in the region of 10^{-4}. The solutions were found to follow the Sievert's law; a constant relative partial modal enthalpy of –12.41 kcal/g-atom was determined, and the relative partial molal entropy was proved to be essentially independent of temperature. The partial molal entropy of dissolved hydrogen and the relative partial molal free energy were evaluated at 500° for different atom ratios from 10^{-4} to 10^{-3}. (auth)

82 THERMODYNAMIC PROPERTIES OF HYDROGEN AND DEUTERIUM IN α-ZIRCONIUM. Ricca, Franco (Univ., Turin). J. Phys. Chem., 71: 3632-7(Oct. 1967).

Solutions of deuterium in α-zirconium, in the atom ratio range of 10^{-4}, were studied over the temperature interval from 450 to 800°. Only minor differences were found to distinguish the deuterium from the hydrogen solutions. The data gathered for both gases were evaluated in terms of the model of Gulbransen and Andrew, which assumes the dissolved atoms to occupy the tetrahedral interstices in the metal lattice and their motion to be a purely vibrational one. Such a model was not found applicable to the experimental data, which seem to indicate a larger mobility of dissolved species. (auth)

83 $U_3O_3F_8$: A NEW COMPOUND IN THE U–O–F SYSTEM. Otey, M. G.; LeDoux, R. A. (Union Carbide Corp., Paducah, Ky.). J. Inorg. Nucl. Chem., 29: 2249-56(Sept. 1967).

A new compound, $U_3O_3F_8$, was prepared by the reaction of UF_6 with a very small quantity of water. This material is thermally stable up to 408°C, but reacts rapidly with water yielding UO_2F_2. It also reacts readily with ClF_3 giving the same reaction products as UO_2F_2. The ClF_3 reaction studies were used as an analytical procedure to establish the oxygen content and as part of the procedure to determine that the material was a true compound. Another uranium oxyfluoride, believed to be $U_2O_3F_6$, was also prepared and a discussion of the U–O–F system is presented. It is proposed that there are at least three uranium(VI) oxyfluorides in addition to the well known uranyl fluoride, UO_2F_2. UOF_4 may well exist although repeated attempts to prepare it were unsuccessful. Only hexavalent uranium compounds were considered in the study. (auth) (UK)

84 DEUTERIUM ISOTOPE EFFECT ON THE ULTRAVIOLET SPECTRUM OF BIPHENYL. Leffek, K. T. Can. J. Chem., 45: 2115-17(Sept. 1967).

Measurements on the ultraviolet absorption for biphenyl and biphenyl-d_{10} verified a small increase in the extinction coefficient, which is believed to be due to the ortho-deuterium atoms. The results do not however, give a definite measure of how important steric effects are as a source of secondary deuterium isotope effects in general. (F.S.A.) (CANADA)

85 LATTICE CONSTANTS OF Rb_2MF_6; M = URANIUM THROUGH CURIUM. Keenan, Thomas K. (Los Alamos Scientific Lab., N. Mex.). Contract W-7405-eng-36. Inorg. Nucl. Chem. Lett., 3: 463-7(Oct. 1967). (LA-DC-8933).

The compounds Rb_2NpF_6, Rb_2PuF_6, and Rb_2CmF_6 were prepared and their lattice constants determined. A recent single-crystal study on Rb_2UF_6 by F. H. Kruse enabled assignment of atom positions, so that x-ray powder diffraction data could be more accurately assigned and some earlier data on Rb_2UF_6 and Rb_2AmF_6 could be more accurately interpreted. These Rb_2MF_6 compounds are orthorhombic, Space Group Cmcm, 4 molecules per unit cell. Lattice constants are tabulated, together with partial powder patterns for Rb_2PuF_6. (auth) (UK)

86 UNIT CELLS OF SOME AMERICIUM(III) SALTS WITH ORGANIC ANIONS. Weigel, F.; Meer, N. ter (Univ., Munich). Inorg. Nucl. Chem. Lett., 3: 403-8(Oct. 1967).

The crystal structure of Am (III) organic salts was studied. The unit cell data, from x-ray powder patterns, were determined for the oxalate decahydrate, $Am_2(C_2O_4)_3 \cdot 10H_2O$, the formate, $Am(HCOO)_3$, and the carbonate dihydrate, $Am_2(CO_3)_3 \cdot 2H_2O$. The x-ray powder data were tabulated, with lattice constants, symmetry, and space group (where known). (UK)

87 TRANSITION-STATE MODELS AND HYDROGEN-ISOTOPE EFFECTS. Weston, Ralph E. Jr. (Brookhaven National Lab., Upton, N. Y.). Science, 158: 332-42(Oct. 20, 1967).

Use of kinetic isotope effects to test detailed models of reacting systems is discussed and examples are given. It is shown that the transition state theory of chemical kinetics coupled with relatively crude methods of constructing potential-energy surfaces for reacting systems has great utility in the forecasting of kinetic properties. It permits prediction of the effect of isotopic substitution on rate constants and comparison of these predictions with data provides a sensitive test for the combination of potential energy surface and transition-state theory. (M.C.G.)

88 ISOTOPIC EXCHANGE ON GAS-CHROMATOGRAPHIC COLUMNS. Balint, Tibor; Szepesy, Laszlo (Hungarian Petroleum and Natural Gas Research Inst., Veszprem). J. Chromatogr., 30: 433-7(Oct. 1967). (In German).

Isotopic exchange in a gas chromatographic column is a well-known method for preparing labeled compounds. The main feature of this method is simultaneous isotopic exchange and separation of a mixture. The degree of isotopic exchange can be varied

by changing the temperature and contact time and by using a catalyst. This provides the possibility of labeling, identifying, and determining different types of organic compounds (alcohols, ketones, mercaptans, olefins, etc.) in complex mixtures. Examples are given to demonstrate the application of the method. Owing to the high sensitivity of the detector the method can also be applied to trace analysis (auth)

89 THE THERMAL DECOMPOSITION OF HYDRAZINIUM (+1)- AND HYDROXYAMMONIUM PENTAFLUORO URANATES (IV). Larkworthy, L. F.; Phillips, D. J. (Univ. of Surrey, London). J. Inorg. Nucl. Chem., 29: 2112-17(Aug. 1967).

Previously reported values for the overall weight losses (11.08 and 7.90%, respectively) during the thermal decomposition of hydrazinium(+1)- and hydroxyammonium-pentafluoro uranates (IV) are in disagreement with the expected values of 14.22 and 14.44% for the decomposition to UF_4. A re-investigation of these thermal decompositions was made. Experimental methods are described for preparation of the compounds, carrying out the thermal decomposition, and infrared examination of the products. Both thermogravimetric and differential thermal analyses were simultaneously performed. Results are presented and discussed, and chemical equations constructed for the various decomposition stages. Weight losses were in reasonable agreement with previously reported values. (UK)

90 THE MECHANISM OF THE OXIDATION OF CARBON MONOXIDE ON LANTHANUM OXIDE. Sazonov, L. A.; Artamonov, E. V. (Inst. of Catalysis, Novosibirsk, USSR). Kinet. Kataliz, 8: 640-5(May-June 1967). (In Russian).

The mechanism of the oxidation reaction of CO on La oxide was investigated in the temperature range from 300 to 420° using radioactive carbon ^{14}C. Below 300° the reaction proceeded with the activation energy E_1 = 3 kcal/mole and was accompanied by complete adsorption of the CO_2 formed on the surface of the oxide. In the range from 300 to 400° the desorption of CO_2 with the activation energy E_2 = 19 kcal/mole appeared to be the limiting stage. Above 400° the rate of chemisorption with $E_3 = E_1$ = 3 kcal/mole was the limiting stage. It is proposed that the oxidation reaction of CO proceeds through the stage of the formation of complexes of the type CO_3^{2-} with the dissociation activation energy $CO_3^{2-} \rightarrow CO_2 + O^{2-}$ = 40 kcal/mole. (tr-auth)

91 CONTRIBUTION TO THE PHOSPHORESCENCE OF CaO PHOSPHORS. Witzmann, H.; Anderson, H.; Roemer, K.-J. (Ernst-Moritz-Arndt-Univ., Griefswald, Ger.). Z. Phys. Chem. (Leipzig), 235: 33-8(1967). (In German).

The decay characteristics of the CaO(Th, Sn) system are not usually constant over a wide temperature range. In addition to exponential and hyperbolic characteristics, more or less sharp intermediate stages were passed through. (tr-auth)

92 THE STRUCTURE OF THE EMISSION BANDS OF Sn- AND Th-ACTIVATED CaO PHOSPHOR. Witzmann, H.; Anderson, H.; Roemer, K.-J. (Ernst-Moritz-Arndt-Univ., Greifswald, Ger.). Z. Phys. Chem. (Leipzig), 235: 8-16(1967). (In German).

A Gaussian analysis was made of the emission bands of Sn- and Th-activated CaO, using two analytical methods. The spectral-energy distribution of the system was calculated for temperatures between 79 and 321°C. The experimental results agreed well with the values obtained using the Pekar calculation method. (J.S.R.)

93 PROCESS FOR THE REDUCTION OF URANIUM HEXAFLUORIDE. Level, Albert; Vallance, Jacques (to Commissariat a l'Energie Atomique). British Patent 1,087,769. Oct. 18, 1967. Priority date Feb. 25, 1964, France.

A process and apparatus were developed for reduction of UF_6 to UF_4. The process yields high-purity UF_4 in a wide range of bulk densities. The UF_6 is injected under pressure into a sealed chamber filled with hydrogen and the mixture maintained at a temperature between 150 and 500°C. Up to 3% by weight ClF_3 may be added to the reaction mixture. (M.C.G.)

94 IMPROVEMENTS IN OR RELATING TO THE PRODUCTION OF URANIUM TETRAFLUORIDE. Berthot, Jean; Cochet-Muchy, Bernard; Plurien, Pierre (to Commissariat a l'Energie Atomique). British Patent 1,087,768. Oct. 18, 1967. Priority date Feb. 25, 1964, France.

A process for the reduction of uranium hexafluoride to uranium tetrafluoride using a gas, such as hydrogen or ammonia, in the presence of 0.1 to 3% chlorine trifluoride is described. The product obtained was about 100% uranium tetrafluoride, the hexavalent uranium content was nil, the chlorine content was less than 50 ppM, and the level of nuclear purity was acceptable. The density of the uranium tetrafluoride was controlled by the amount of chlorine trifluoride added. (D.H.M.)

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Refer also to abstracts 64, 785, and 1765.

95 (AD-646604) SENSITIZED LUMINESCENCE IN IRRADIATED NOBLE GAS SYSTEMS. Final Report, October 22-November 9, 1964. Sieck, L. W.; Llewellyn, J. A. (Aerospace Research Labs., Wright-Patterson AFB, Ohio). Sept. 1966. 23p. (ARL-66-0180). CFSTI.

Investigations were made of collision-induced luminescence phenomena in high-pressure argon and krypton containing trace amounts of N_2 and O_2 using nominal 2.5-MeV electrons as the primary energy source. High-resolution spectroscopy demonstrated that the C triplet-pi state of N_2 is produced by quenching of the set of argon levels corresponding to approximately 11.5 eV of excitation energy. Evidence is also presented for the occurrence of the reaction N_2 (B triplet-pi-g + O_2 (X triplet-Sigma-g-) to NO (A double-Sigma +) + NO (X doublet-pi). (auth) (TAB)

96 (RRL-2310-214) QUARTERLY REPORT [ON CHEMISTRY], JULY 1, 1967-SEPTEMBER 30, 1967. Fundamental Research No. 6041. (Mellon Inst., Pittsburgh, Pa. Radiation Research Labs.). Oct. 10, 1967. Contract AT(30-1)-2310. 16p. Dep. CFSTI.

Developments are reported for studies on: Spiro Meisenheimer complexes derived from 1-(β-hydroxyethoxy)-2,4-dinitroarenes; Meisenheimer complexes of 1-alkoxy-2,4-dinitronaphthalenes; radioinduced hydroxylation of nitrobenzene in dilute aqueous solution; solvated electron spectrum in irradiated ice; ESR spectra of photolytically produced radicals in SF_6 matrices; ESR-transient radicals in irradiated aqueous solutions; photolysis of CF_3OOCF_3; theoretical consideration of hyperfine splittings in the PF_4 radical; combination and disproportionation of alkyl radicals in liquid methane; electron scavenging in irradiated cyclohexane solutions; effects of negative-ion scavengers on the efficiency of positive ion reactions; gas phase radiolysis of benzene-nitrous oxide mixtures; competitive electron scavenging in irradiated hydrocarbon gases; Hg ($^1P_1$) photosensitized decomposition of cyclopropane; radioinduced hydroxylation of anisole in dilute aqueous solutions; hydrolysis of nitrosubstituted aryl sulfates; photochemical determination of relative rate constants for hydroxyl radical reactions; transient solvated electron and hydroxyl radical in pulse irradiated ice; and mass spectrometry of discharge flow system $N_2 + CH_4$. (P.C.H.)

97 ESR OF γ-IRRADIATED SINGLE CRYSTALS OF ICE AT 77°K. IDENTIFICATION OF THE HYDROXYL RADICAL AND ITS TRAPPING SITE. Dibdin, G. H. (Chelsea Coll., London). Trans. Faraday Soc., 63: 2098-2111(Sept. 1967).

The ESR spectra of γ-irradiated single crystals of ice and heavy ice at 77°K were studied. Analysis shows the complex spectrum to be consistent with OH or OD radicals trapped at 24 sites which differ in orientation but are otherwise indistinguishable. It is suggested that the radical is in a relaxed substitutional site roughly parallel to any one of the perpendicular bisectors of the faces of the two non-equivalent tetrahedra formed by the oxygen atoms in the crystal lattice. The experimentally derived tensors were consistent with theory for OH radicals in the proposed trapping site. Annealing studies showed the radicals to disappear according to first-order kinetics; this finding is discussed in terms of the proposal for a substitutional radical site. (auth) (UK)

98 ELECTRON SPIN RESONANCE OF AN IRRADIATED SINGLE CRYSTAL OF CYTOSINE. Cook, J. B.; Elliott, J. P.; Wyard, S. J. (Guy's Hospital Medical School, London). Mol. Phys., 13: 49-64(1967).

Electron spin resonance spectroscopy was used to investigate radiation damage in irradiated single crystals of cytosine grown from both water and deuterium oxide. At least three radicals are produced by the radiation and two of these species were identified. (auth)

99 LIQUID-PHASE RADIOLYSIS OF 2,3,4- AND 2,2,4-TRIMETHYLPENTANES. INTERPRETATION OF CARBON-CARBON BONE RUPTURE REACTIONS FROM THE EFFECTS OF ADDITIVES. Kudo, T. (Tokyo Inst. of Tech.). J. Phys. Chem., 71: 3681-4(Oct. 1967).

The effects of postirradiative additions of iodine on the products from γ-irradiated 2,2,4- and 2,3,4-trimethylpentane were studied. Olefin yields were considerably reduced. It was concluded that radical yields of these products cannot be obtained by using iodine as a radical scavenging agent. The addition of methyl methacrylate monomer to 2,3,4-trimethylpentane gave true molecular yields for olefins. A revised interpretation is given of the previously reported G-values of C-C bond rupture reactions of 2,2,4-trimethylpentane. (J.G.B.)

100 REACTION OF DILUTE AQUEOUS CH_3I WITH IODINE ACTIVATED BY NUCLEAR PROCESSES. Wilkey, D. D.; Brensike, J. F.; Willard, J. E. (Univ. of Wisconsin, Madison). Contract AT(11-1)-32. J. Phys. Chem., 71: 3580-3(Oct. 1967).

Dilute aqueous solutions of $CH_3{}^{127}I$ and $I_2{}^{(129}I$ [or $I^{-(129}I$] were irradiated with neutrons and analyzed to determine the fractions of the $^{127}I(n,\gamma)^{128}I$ and $^{129}I(n,\gamma)^{130}I$ events which lead to ^{128}I and to ^{130}I in organic combination. The organic yield of each isotope was significant, confirming an earlier report that organic combination of (n,γ)-activated iodine atoms can be achieved in aqueous CH_3I-I_2 systems, but showing that such combination does not require the geminate retention previously postulated. The yields were independent of the I^- concentration from 10^{-5} to at least 10^{-3} mole % and increased with CH_3I concentration in the range from 1.8×10^{-3} mole % to the saturated solution concentration of 0.18 mole %. Like the (n,γ) processes, the $^{130m}I \rightarrow {}^{130}I$ isomeric transition in aqueous solutions of 0.08 mole % CH_3I and 10^{-3} mole % $I_2{}^{(130m}I)$ or $I^{-(130m}I)$ led to organically bound ^{130}I, the organic yields being about 7%. The entry into organic combination of I atoms originating from I_2 or I^-, and activated by the (n,γ) or IT process, seems to be explained most plausibly in terms of the autoradiation hypothesis. Techniques were developed for correcting for thermal exchange in the systems used. It was found that photochemically produced I atoms do not exchange readily with CH_3I in aqueous solution. (auth)

101 SZILARD–CHALMERS CHEMISTRY OF C_6H_{14}–$R^{127}I$–$^{129}I_2$ SOLUTIONS. Chang, H. M.; Willard, J. E. (Univ. of Wisconsin, Madison). Contract AT(11-1)-32. J. Phys. Chem., 71: 3576-9(Oct. 1967).

When hexane containing $I_2(^{127}I)$ and $I_2(^{129}I)$ was irradiated with neutrons, nearly equal percentages of the ^{128}I and the ^{130}I formed appeared in organic combination, indicating that the $^{127}I(n,\gamma)^{128}I$ process, the $^{129}I(n,\gamma)^{130}I$ process, and the isomeric transition process of ^{130m}I endow the daughter atoms with equal or nearly equal chemical reactivity. When hexane containing $I_2(^{129}I)$ and $i\text{-}C_3H_7{}^{127}I$ (or $C_2H_5{}^{127}I$) was irradiated with neutrons, the organic yields of ^{128}I and ^{130}I were again equal and the yields of $i\text{-}C_3H_7{}^{128}I$ and $i\text{-}C_3H_7{}^{130}I$ (or $C_2H_5{}^{128}I$ and $C_2H_5{}^{130}I$) were also equal, indicating little recombination of the recoil atoms with sibling partners. The mechanistic implications of these facts and the effects of concentration on the organic yields are considered. (auth)

102 RADIOLYSIS OF METHYLCYCLOHEXANE. III. PURE VAPOR PHASE AND EFFECTS OF ADDITIVES. Holtslander, W. J.; Freeman, G. R. (Univ. of Alberta, Edmonton). Can. J. Chem., 45: 1649-59(July 15, 1967).

The radiolysis of methylcyclohexane (MCH) vapor was carried out under a variety of conditions. The G-values of the main products at 110°, extrapolated to zero dose, were hydrogen (5.2), methylcyclohexene isomers (2.0), ethylene (1.5), methane (1.3), propylene (0.8), and total dimer (0.3). Other products were also measured. The hydrogen yield was reduced to G = 3.1 by each of the additives, N_2O, SF_6, and CCl_4, and to G = 1.6 by C_2H_4. Both DI and ND_3 increased the total hydrogen yield above the value in pure MCH. In pure MCH approximately 50% of the ions (G(total ionization) = 4.4) resulted in hydrogen formation, whereas in the presence of DI or ND_3, 75% of the ions are hydrogen precursors. Thus three different types of positive ions are distinguished in the system: $G(M_1^+) = 2.1$, $G(M_2^+) = 1.3$, and $G(N^+) = 1.0$. The average ion lifetime with respect to neutralization was 10^{-3} sec. The ion DI^- was therefore stable with respect to decomposition to D + I^- for a period greater than 10^{-3} sec under the conditions of the experiments (~380 Torr MCH, 110°). The yield of methylcyclohexene isomers increased with increasing temperature and increased upon addition of ND_3 or C_2H_4 to the radiolysis system. The dimer yield was also enhanced by the addition of ND_3. This effect was explained by the occurrence of an ionic secondary reaction that destroys methylcyclohexene and (or) methylcyclohexyl radicals in pure MCH. Approximately 85% of the methane was produced by methyl radicals abstracting hydrogen atoms from MCH. (auth) (UK)

103 RADIOLYSIS OF METHYLCYCLOHEXANE. IV. EFFECTS OF CARBON TETRACHLORIDE AND NITROUS OXIDE IN THE VAPOR PHASE. Holtslander, W. J.; Freeman, G. R. (Univ. of Alberta, Edmonton). Can. J. Chem., 45: 1661-8(July 15, 1967).

The radioinduced chain reaction in methylcyclohexane (MCH)–CCl_4 mixtures in the vapor phase at 110° and 380 Torr produces chain-propagation products of chloroform and methylcyclohexylchloride ($G_{max} \approx 40$). The chain-termination products were mainly methylcyclohexene (MC), bimethylcyclohexyl (C_{14}), and hexachloroethane, depending on the composition of the mixture. At CCl_4 concentrations < 1 mole %, HCl was formed mainly by reaction of Cl^- with positive ions, e.g. $Cl^- + C_7H_{14}^+ \rightarrow HCl + C_7H_{13}$. The value of the ratio $G(MC)/G(C_{14})$ was 8 ± 1 in pure MCH and in the mixtures up to 44 mole % CCl_4. A radioinduced chain reaction also occurred in MCH–N_2O mixtures in the vapor phase. At 110° and 380 Torr, $G(N_2) = 22$, G(MC) = 16, and $G(C_{14}) = 1.6$, independent of N_2O concentration between 2 and 10 mole %. The G-values were independent of MCH pressure between 50 and 520 Torr. Product formation was inhibited by the addition of SF_6 or DI. The half-life of the ion N_2O^- with respect to decomposition to $N_2 + O^-$ was $10^{-4}-10^{-3}$ s under these conditions. It is suggested that the mechanism contains the reactions $OH^- + C_7H_{14} \rightarrow H_2O + C_7H_{13}^-$; and $C_7H_{13}^- + N_2O \rightarrow C_7H_{13} + N_2O^-$. The first reaction is slightly exothermic; the second is exothermic if the electron affinity of N_2O is greater than that of C_7H_{13}. (auth) (UK)

104 ELECTRON SPIN RESONANCE STUDIES OF THE HYDROXYL RADICAL IN γ-IRRADIATED ICE. Brivati, J. A.; Symons, M. C. R.; Tinling, D. J. A.; Wardale, H. W.; Williams, D. O. (Univ. of Leicester, Eng.). Trans. Faraday Soc., 63: 2112-16 (Sept. 1967).

A comparison of simulated with experimental ESR spectra of ice and deuterium oxide γ-irradiated at 77°K indicated that the g- and A-tensors of the hydroxyl radical in ice do not possess axial symmetry, although many interpretative difficulties remain. (auth) (UK)

105 PARAMAGNETIC RESONANCE STUDY OF NO_2 IN IRRADIATED KNO_3 AT 4°K. Holmberg, Robert W.; Livingston, Ralph (Oak Ridge National Lab., Tenn.). Contract W-7405-eng-26. J. Chem. Phys., 47: 2552-4(Oct. 15, 1967). (ORNL-P-3121).

The paramagnetic resonance spectrum of NO_2 was studied at 4°K in γ-irradiated single crystals of KNO_3. The g and hyperfine parameters were essentially the same as those for NO_2 in $NaNO_2$ but substantially different from those in KNO_3 at 77°K, indicating that thermal motion at 77°K is frozen out at the lower temperature. (auth)

106 INORGANIC RADICALS TRAPPED IN GLASSES AT ROOM TEMPERATURE. IV. SILVER RADICALS IN METAPHOSPHATE GLASS. Feldmann, T.; Treinin, A. (Hebrew Univ., Jerusalem). J. Chem. Phys., 47: 2754- (Oct. 15, 1967).

The effect of x radiation on silver-activated metaphosphate glass was investigated. The optical and ESR absorptions were measured and assigned to Ag^{2+}, Ag_2^+, and Ag^0. Their optical bands have maxima at 275, 315, and 365 mμ, respectively. The silver atoms, stable at 77°K, show little chemical interaction with the matrix. A new color center belonging to the base glass was identified. It results from the reaction of electrons with the phosphate polymers and exhibits a large hyperfine coupling. Its nature is discussed. (auth)

107 RESEARCH ON WOOD-PLASTIC COMBINATIONS IN SWEDEN. Aagaard, P. (Aktiebolaget Atomenergi, Studsvik, Sweden). Svensk Kem. Tidskr., 19: 501-10(1967). (In Swedish).

From Symposium on Use of Plastics in Wood and Papers, Studsvik, Sweden, Nov. 1966.

An account is given of the development of wood–polymer combinations at Studsvik Nuclear Research Center. The pine–methylmethacrylate (MMA) system was studied in detail, but other systems are also referred to. The results of impregnation agreed with a free volume model, with the exception of woods containing heartwood or biologically active cells (viz. wood rays) in larger proportions. Polymerization was dependent on the type of monomer, wood, and dose rate as main variables. The dose requirement for full conversion of MMA at ca 75 RAD/sec and 7 RAD/sec was 1.3 and 0.7 MRAD, respectively. Graft polymerization was dependent on dose, the type of wood, diluent for the monomer, and the swelling of the wood. The treatment gave a decidedly higher hardness of the product and a better volume stability. The other physical properties analyzed showed little change if calculated on the basis of product weight. The diffusion of water in the products was impaired by polymer content. The kinetics of change in water content below the fiber saturation point can be treated by first-order methods. (auth) (Sweden)

108 WOOD-PLASTIC COMBINATIONS RESULTS AND EXPERIENCES ABROAD. Kinell, P.-O. (Forskningsradens Laboratorium, Studsvik, Sweden). Svensk Kem. Tidskr., 19: 419-500(1967). (In Swedish).

From Symposium on Use of Plastics in Wood and Paper, Studsvik, Sweden, Nov. 1966.

The radiation effects on wood and the mechanisms for radioinduced polymerization are briefly described. The research and development work abroad on wood–plastic combinations is summarized. Results and experiences on impregnation, irradiation, polymerization, and physical properties of the products are discussed. (48 references). (Sweden)

109 INVESTIGATIONS IN THE FIELD OF RADIATION-INDUCED SOLID-STATE POLYMERIZATION. XXI. Hardy,

Gyula; Nagy, Gabor; Varga, Jozsef; Juhos, Istvan. Magy. Kem. Foly., 73: 257-60(June 1967). (In Hungarian).

The phase diagrams of the binary systems formed by allyl endomethylene-tetrahydrophthalate with N-vinylsuccinimide, succinimide and acetanilide, respectively, were investigated. Depending on the conditions of undercooling and that of nucleation, a quasi-eutectic range of co-crystallization could be observed. For the case of N-vinylsuccinimide and allyl endomethylene-tetrahydrophathalate it was found that the rate of solid state polymerization changes in direct proportion to concentrations of material present of eutectic structure. Thus, it was concluded that in binary systems the proportion having eutectic structure and, consequently, the apparent rate of polymerization markedly depend on the proneness to undercooling and on the process of nucleation. (auth)

110 RADIATION INDUCED IODINE EXCHANGE REACTION. Appleby, A.; Charlton, J. C.; Spillett, R. E. (United Kingdom Atomic Energy Authority, Amersham, Eng.). Chem. Commun., No. 18, 958-9(1967).

A γ-induced exchange reaction between p-iodobenzoate ion and iodide ion in aqueous solutions is reported. A mechanism involving the hydrated electron is suggested. The Cs salt of iodobenzoic acid was used in the studies, because of its solubility in water, together with $Cs^{125}I$. Irradiation conditions were 6.6 MR ^{60}Co gamma radiation. The product was an organic acid labeled with ^{125}I; no incorporation of activity was observed in the absence of radiation. Cesium p-[^{125}I] iodobenzoate was also irradiated under similar conditions in the presence of inactive iodide; the specific activity of the acid formed decreased on irradiation. It was thus shown that a genuine isotopic iodine exchange was being observed. In order to incorporate a significant fraction of the active iodide into the organic molecule, using moderate radiation doses, it is necessary to use solute concentrations lower than about 10^{-1}M. The effect of varying pH and solute concentration was examined, and also the effect of thiosulphate on the exchange yield. Results suggest that the formation of molecular iodine is important in the exchange process. Mechanisms are suggested. Iodoaromatic compounds react rapidly with hydrated electrons, giving iodide and an organic radical, and organic radicals are efficiently scavenged by iodine, and in the system investigated this would lead to exchange. (UK)

111 CHEMICAL COMPOUNDS OF RADIOACTIVE PHOSPHORUS PRODUCED BY PILE IRRADIATION OF SULFUR COMPOUNDS, BOTH SOLID AND IN SOLUTION. Moro, Antonino Lo; Frediani, Sergio (Univ., Pisa, Italy). J. Inorg. Nucl. Chem., 29: 1837-46(Aug. 1967). (In French).

The oxidation states of ^{32}P produced from $^{32}S(n,p)^{32}P$ reaction, after in-pile irradiation of sulphur compounds, were studied as a function of the associated gamma dose. Irradiations were made on sodium salts, both as solids and in aqueous solutions (sulfite, thiosulfate, pyrosulfite, thiocyanate, dithionate, as well as thiourea). The chemical species of the radioactive phosphorus were determined by the method of gradient elution anion-exchange chromatography. It is suggested that, in solids, the phosphorus distribution in the various oxidation states may be related to the structures of anions. For aqueous solutions, the chemical state of the phosphorus atoms may be influenced mainly by the different sensitivity to radiolytic decomposition of the irradiated substances. (auth) (UK)

112 ISOMERIZATION POLYMERIZATION OF 2-VINYL-1,3-DIOXOLANE BY α,α'-AZOBISISOBUTYRONITRILE OR BY γ-RAY IRRADIATION. Kagiya, Tsutomu; Nakayama, Takeo; Nakai, Yoshio; Fukui, Kenichi (Kyoto Univ.). J. Polym. Sci., Part A-1, 5: 2351-8(Sept. 1967).

2-Vinyl-1,3-dioxolane was polymerized by use of α,α'-azobisisobutyronitrile (AIBN) or by γ-irradiation. The polymer obtained was a white amorphous powder which melted at ca 70°C and was soluble in chloroform, acetone, and p-dioxane. The infrared spectrum of the polymer indicated peaks at 1735 cm^{-1} characteristic of the carbonyl group, and at 1200 to 1000 cm^{-1} characteristic of the acetal group, while no absorption at 990 and 3100 cm^{-1} due to the vinyl group was observed. The spectra of the polymers obtained by AIBN and by γ-irradiation were essentially identical. The saponified product of the polymer was white powder and its reduced viscosity was a little larger than that of the original polymer. These results indicate that the polymer has no ester unit in the main chain. The results of gas chromatographic analysis of the saponified product of the polymer indicate the presence of a small amount of ethyl alcohol. The results of the saponification showed that the ester content in the polymer varied from 7 to 25% depending upon the polymerization temperature. These results indicate that 2-vinyl-1,3-dioxolane polymerized by AIBN or by γ irradiation with two modes of vinyl and hydrogen migration and the unit structures are given. (auth)

113 RADIATION-INDUCED POLYMERIZATION OF ISOBUTENE IN THE LIQUID AND GLASSY STATES. Milyutinskaya, R. I.; Bagdasar'yan, Kh. S. (Inst. of Physics and Chemistry, Moscow). Kinet. Kataliz, 8: 677-83(May-June 1967). (In Russian).

The yield of the initial products, G, of carefully purified isobutylene at 195°K is equal to 0.5; the mean length P of the polymer chain is 10^4. From these data it follows that 15% of the secondary electrons recombine with the original ions in less than 10^{-7} sec, and the path of these electrons does not exceed 200 Å. The polymerization of isobutylene in glassy solutions of methylcyclohexane (1.4 : 1) at 77°K is characterized by the magnitudes G = 2.3 and T = 10^2. The presence of aromatic amines in the glass decreases both the yield of the polymer and its molecular weight. Simultaneously the formation of cation radicals of these amines occurs. The processes occurring in the presence of the amines are considered. (tr-auth)

114 SCINTILLATION CHARACTERISTICS OF DOPED ORGANIC MOLECULE SINGLE CRYSTALS ON BOMBARDMENT WITH α PARTICLES. Kaiser, Gerold C. (Univ., Goettingen, Ger.). Z. Phys., 207: 73-82(1967). (In German).

Scintillation anisotropy of organic crystals containing impurities was measured. Single crystals of t-stilbene with impurities of anthracene and naphthacene and single crystals of p-terphenyl containing anthracene were bombarded with α-particles in order to investigate their scintillation response as function of direction of α-particles and concentration of guest molecules. The relations between the results and the polarization of the fluorescent light of the corresponding molecules are discussed. (auth)

115 ELECTRON SPIN RESONANCE IN X-IRRADIATED SODIUM SULPHATE. Hariharan, N.; Sobhanadri, J. (Indian Inst. of Tech., Madras). Curr. Sci. (India), 36: 534(Oct. 20, 1967).

Single crystals of Na_2SO_4 were irradiated with x rays and the electron spin resonance spectra of the induced magnetic centers were obtained at room temperature. The crystals were rotated about three orthogonal crystallographic axes every five degrees. The single crystals were grown from aqueous solution by slow evaporation and repeated crystallization. From x-ray diffraction measurements the orthorhombic unit of Na_2SO_4 was found to have the unit cell dimensions a_0 = 5.85; b_0 = 12.29; and c_0 = 9.75 Å with 8 molecules per unit cell in agreement with previous work. The crystals, on irradiation, slowly developed a beautiful purple coloration. The observed ESR spectra consisted of several lines and the centers were stable for days in the dark at room temperature. (D.H.M.)

116 EVIDENCE OF THE INFLUENCE OF CRYSTAL DEFECTS ON THE ANNEALING OF CHEMICAL RADIATION DAMAGE. Mohanty, S. R.; Nair, S. M. K. (Banaras Hindu Univ., India). Curr. Sci. (India), 36: 536-7(Oct. 20, 1967).

Observations on annealing in irradiated lead nitrate containing lattice defects introduced by doping and fast-neutron bombardment are given. Homogeneous crystals of lead nitrate containing various concentrations of aluminum ions in the range 10^{-4} to 10^{-1} mole fraction were prepared by slow evaporation of aqueous solutions. Samples of the untreated and doped crystals were irradiated with 50 MRAD of ^{60}Co γ radiation at the dose rate of 1.5 MRAD/hr. The initial damage, measured as nitrite, was larger the higher the concentration of the impurity ions. The doping accelerated the annealing process. A comparison was made of the initial damage and the thermal annealing behavior of lead nitrate irradiated with 50 MRAD of γ rays with the substance irradiated close to the reactor core so as to receive the same dose of γ rays and in addition 5×10^{15} nvt fast and 2.2×10^{16} nvt slow neutrons. Apart from the chemical damage a considerable concentration of displacements was produced by the knock-on collisions of chiefly the fast neutrons. The initial chemical damage in irradiation with only γ rays was smaller than that with γ rays plus neutrons. (D.H.M.)

117 TEMPERATURE EFFECTS ON NATURE AND REACTIONS OF METASTABLE SPECIES IN γ-IRRADIATED 3-METHYLPENTANE–CARBON TETRACHLORIDE GLASSES AT 20 AND 77°K. Claridge, R. F. C.; Iyer, R. M.; Willard, J. E. (Univ. of Wisconsin, Madison). Contract AT(11-1)-32. J. Phys. Chem., 71: 3527-30(Oct. 1967).

Gamma irradiation of 3-methylpentane (3MP) glass containing 1 mole % CCl_4 at 20°K produced a new trapped reaction intermediate (absorbing at 3660 A), which was not observed at 77°K, but did not produce the previously reported CCl_3^+ (4800-A peak) species found following 77°K irradiations. The new species decayed at a measurable rate at 50°K and very rapidly at 77°K. It was bleached at 20°K by radiation in its own absorption band. Possible assignments of the new peak are discussed because caging effects

are greater. It is suggested that the absence of the 4800-A peak following irradiations made below 77°K is due to temperature sensitivity of the specialized charge-migration process necessary to produce CCl_4^+. (auth)

118 HEAVY WATER PROCESS DEVELOPMENT AT CHALK RIVER. Rea, H. K. (Atomic Energy of Canada, Ltd., Chalk River, Ont.). Chem. Can., 19: No. 5, 44-6(Oct. 18, 1967).

The water–hydrogen sulfide (GS process) and the ammonia–hydrogen exchange process based on water feed, are compared. Consideration of raw materials sources, operating costs, and possible engineering improvements favor the GS process for Canadian production. (F.S.A.) (CANADA)

119 POWER COST REDUCTION FROM ISOTOPE REVENUES. Lang, L. W. (Douglas United Nuclear, Inc., Richland, Wash.); Deonigi, D. E.; Rohrmann, C. A. Contract AT(45-1)-1830. Nucl. Appl., 3: 665-78(Nov. 1967). (BNWL-SA-1187).

The fission process produces not only isotopes of interest as heat sources, but elements, e.g., rhodium, palladium, and xenon, that may ultimately be used as articles of commerce. Augmenting the supplies of the same rare elements as derived from nature such materials are produced in all nuclear power reactors and the revenue from their sale could be used to reduce nuclear power costs. A cautious optimism toward this possibility is suggested by consideration of the properties of these materials, methods and costs of their production and separation, and their uses and possible market value. (auth)

120 CHEMISTRY OF NEW ATOMS. Shantarovich, V. P.; Firsov, V. G. (Inst. of Chemical Physics, Moscow). Vestn. Akad. Nauk SSSR, No. 5, 47-55(May 1967). (In Russian).

The chemical reactions of positrons, muons, and atomic H were compared, and the possibility of using these reactions in the study of chemical kinetics and radiation chemistry was shown. (J.S.R.)

121 PHOTOELECTRIC CHARACTERIZATION OF X-RAY DAMAGE IN ANTHRACENE CRYSTALS. Kronick, P. L.; Labes, M. M. (Franklin Inst. Research Labs., Philadelphia). Mol. Cryst., 2: 293-7(1967).

For examination of current-carrier traps, an anthracene crystal was subjected to transient photocurrent measurement after x irradiation. Since the photocurrent pulse-heights increased with light intensity and varied nearly linearly with applied electric field, it was accepted that the currents were not space-charge limited, and that in the decay of a pulse a depletion of free holes in the bulk of a crystal was observed. Annealing studies of x-irradiated anthracene crystals at various temperatures and atmospheres produced no change in electrical properties. Effects of dose rates from 0 to 6400 RAD on pulse-decay times are discussed. After the second irradiation, pulse-decay times dropped from 56 to less than 30 sec. Since the yield agreed with previous studies using x and γ rays, it is suggested that the source of ionizing radiation has only a small effect on the resulting traps in anthracene crystals. (P.C.S.)

122 RADIATION CHEMICAL DATA IN WATER USING NITROUS OXIDE. Head, D. A.; Walker, D. C. (Univ. of British Columbia, Vancouver). Can. J. Chem., 45: 2051-8(Sept. 1967).

By using small doses and very low dose rates, it was found that in the γ irradiation of water $\sim 8 \times 10^{-6}$ M nitrous oxide completely scavenges e^-_{aq} in the absence of other additives and gives a yield $G(e^-_{aq}) = 2.45 \pm 0.1$. When used at concentrations of ~15 mMole, N_2O scavenges a second species having a yield $G = 0.65 \pm 0.1$, which can probably be attributed to a hydrated hydrogen atom species resulting from the reaction of e^-_{aq} with H_3O^+ within the spur. Previous studies on the competition between N_2O and H^+_{aq} for e^-_{aq} have been conducted at concentrations of N_2O much too high for simple competition to be valid, which probably accounts for the erratic results obtained. Studies on the competition at $\sim 10^{-4}$ M are reported. The results cannot be interpreted either in terms of a simple competition or by one, or both, of the immediate products reacting with either of the additives. The data can only be rationalized by assuming that in acid solution N_2O is converted to a species, tentatively suggested to be $H_2N_2O_2$, which reacts with e^-_{aq} 5 times more slowly than does N_2O_{aq} at pH 7. (auth) (UK)

123 CONFIGURATIONS OF THE FREE RADICALS IN IRRADIATED POLYPROPYLENE AND THE RELATION OF THEIR DECAY REACTIONS TO THE MOLECULAR MOTION. Nara, S.; Kashiwabara, H.; Sohma, J. (Hokkaido Univ., Sapporo). J. Polym. Sci., Part A-2, 5: 929-38(Sept. 1967).

Free radicals produced in irradiated polypropylene were studied by the electron spin resonance method. Two temperature regions in which the free radicals decay rapidly were found at around 170 and 260°K. The first temperature region corresponds to the γ-dispersion of polypropylene and the second to the β-dispersion. Steric configurations of the free radicals were investigated, and it was concluded that the free radicals trapped in polymer, conformation of which is appreciably twisted from the stable 3_1-helical structure, decay with small-scale motion of the matrix polymer. The decay of free radicals trapped in polymer of less twisted conformation is associated with the large-scale motion of the matrix polymer. Activation energies of decay were found to be 11 kcal/mole at the lower temperature and 48 kcal/mole at the higher temperature. Time constants of the decay reactions were compared with those for molecular motion of the matrix, with results reflecting the relation of the decay of the polymer radicals to molecular motion in the matrix. (auth)

124 THE β BACKSCATTERING OF SOME ORGANIC SOLVENTS. Mika, Jozsef; Beck, Ivan; Inzeltne, Gerber Edit. Magy. Kem. Foly., 73: 269-73(June 1967). (In Hungarian).

The β-backscattering of some organic solvents and their aqueous solutions was studied. It was concluded that depending on the water content, the β-backscattering of organic solvent–water mixtures differs more or less from the value calculated by the Müller equation. These differences may be explained by the effect of different hydration conditions. Experiments with some isomeric organic compounds indicated that β-backscattering considerably depends (besides the atomic number of the target component) upon the type of chemical bond present. (auth)

125 PROPERTIES OF FREE RADICALS FORMED BY IRRADIATION OF WATER AND METHYL ALCOHOL ADSORBED ON SYNTHETIC ZEOLITES. Zalevskaya, R. I.; Tsvetkov, Yu. D. (Inst. of Chemical Kinetics and Combustion, Novosibirsk, USSR). Kinet. Kataliz, 8: 542-9(May–June 1967). (In Russian).

The radicals $\dot{H}$, $\dot{O}H$, $C\dot{H}_2OH$, formed at 77°K by ^{60}Co irradiation of synthetic zeolites of the A and X type with adsorbed water and methanol, were investigated by the EPR method. The kinetics of the accumulation of the radicals in these systems were studied and data on the radical yield Z_R for different charging of the zeolites are reported. It was found that accumulation of the radicals in the adsorbed substances has a series of characteristics different from those of the pure substances irradiated under the same conditions. Behavior of the radical during heating of the samples above 77°K was studied. The stability of the radicals was determined by the structure parameters of the zeolites and the mobility of the adsorbed molecule. Recombination of the radicals $\dot{O}H$ and $C\dot{H}_2OH$ had a multistage character. Destruction of the H radicals occurred bimolecularly with the velocity constant $k_H = 4.2 \times 10^{-16} e^{(-4600 \pm 800)/RT}$ cm³/sec. (tr-auth)

126 STUDIES OF SOLID PHASE RADIATIVE POLYMERIZATION OF BUTYLENE GLYCOL DIMETHACRYLATE. Gusakovskaya, I. G.; Gol'danskii, V. I. (Inst. of Chemical Physics, Moscow). Vysokomol. Soedin., Ser. B, 9: 390-2 (May 1967). (In Russian).

At any freezing velocity of the samples, polymerization at –196°C does not occur immediately under γ irradiation within the experimental limits. During fractional irradiation of the samples the polymers are formed in the fusion range if samples are frozen, before irradiation, at a rate of approximately 1°/min. If the freezing rate before irradiation is 600°/min, then the polymerization under fractional irradiation proceeds in two regions from 107 to 85°C (the crystallization temperature) and in the fusion range. (tr-auth)

Radiochemistry

Refer also to abstract 24.

127 (RCC-R-209) STUDIES OF THE EFFECTS OF RADIATION ON AQUEOUS SOLUTIONS OF 3:5-DIIODOTYROSINE. Appleby, A. (Radiochemical Centre, Amersham (England)). July 1967. 35p. Dep. CFSTI. UK 5s. 0d.

The self-decomposition of ^{131}I-labeled 3,5-diiodo-L-tyrosine stored in aqueous solution was studied. The percentage decomposition for a given absorbed radiation dose was shown to be independent of specific activity over a wide range, and a marked protecting effect of dissolved oxygen was observed. These and other effects are shown to be consistent with a postulated reaction mechanism in which the radiolytically produced hydrated electron is an important intermediary. The protecting capacities of a number of solutes were studied and correlated with their reactivities towards the hydrated electron. (auth) (UK)

128 CATALYTIC ACTIVITY OF Fe, Co, AND Ni OXIDE DURING ISOTOPIC EXCHANGE REACTIONS IN CO_2 MOLECULES. Amerikov, V. G.; Boreskov, G. K.; Kasatkina, L. A. (Moscow Inst. of Chemistry and Tech.). Kinet. Kataliz., 8: 646-53(May–June 1967). (In Russian).

In the temperature interval from –78 to 350°C and at CO_2 pressures from 4 to 200 mm Hg, the isotopic exchange of O_2 in CO_2 molecules on the surface of Fe_2O_3, Co_3O_4, and NiO was investigated. The metal oxides were heat treated in vacuo at 350°C and aged under stationary conditions in CO_2 or O_2 atmosphere before the test. It was found that the exchange reactions in all cases proceed with high velocity and low activation energy. The exchange velocity depends on the preliminary processing of the oxide. (tr-auth)

Separation Processes

Refer also to abstracts 283, 1816, 1914, and 1915.

129 (AD-648138) ION-EXCHANGE METHODS FOR CONCENTRATION OF TRACE ELEMENTS FROM SEAWATER. AN ANNOTATED BIBLIOGRAPHY OF METHODS, APPLICABLE ALSO TO ANALYSIS AND TO RELATED SOLUTIONS. Pascual, J. (Naval Radiological Defense Lab., San Francisco, Calif.). Nov. 15, 1966. 45p. (USNRDL-TR-67-16). CFSTI.

The concentration of trace elements from seawater and similar solutions is described for a number of trace elements. Both organic and inorganic exchangers are used to concentrate trace elements from solutions. Some concentration methods require no pH adjustment of solutions prior to adsorption and can therefore be used in situ. Others require some solution treatment prior to adsorption and can therefore be applied only in the laboratory. New organic and inorganic exchangers are being constantly developed. A good agent for concentrating Cs from seawater is the inorganic exchanger ammonium molybdophosphate (AMP), which requires little or no solution treatment prior to adsorption. (TAB)

130 (AERE-M-1948) THE PREPARATION OF SATURATED ^{63}Cu AND ^{65}Cu PERCHLORATE SOLUTIONS IN HEAVY WATER. Barnes, K. C.; Maude, B. M.; Wilkinson, K. L. (Atomic Energy Research Establishment, Harwell (England)). Aug. 1967. 4p. Dep. CFSTI. UK 1s. 2d.

The separation of gram quantities of ^{63}Cu and ^{65}Cu from copper tin alloys, and the subsequent preparation of their saturated perchlorate solutions in heavy water are described. (auth) (UK)

131 (AERE-R-2945) STUDIES ON MONO- AND DI-n-BUTYLPHOSPHORIC ACIDS. PART 3. THE EXTRACTION OF ZIRCONIUM FROM NITRATE SOLUTION BY DI-n-BUTYLPHOSPHORIC ACID. Hardy, C. J.; Scargill, D. (Atomic Energy Research Establishment, Harwell (England)). Aug. 1959. 21p. Dep. CFSTI. UK.

The extraction of ~10^{-6} M zirconium from nitrate solutions by di-n-butylphosphoric acid (HDBP) has been studied as a function of the concentrations of HDBP, nitric acid, nitrate-ion, and hydrogen ion. The distribution coefficient for zirconium is proportional to the third power of the final [HDBP monomer]$_{org}$ over the range 10^{-5} to 10^{-3} M HDBP, and to the first power of the $[NO_3^-]$ and is independent of the $[H^+]$ at a constant ionic strength of 2. The mechanism of extraction of zirconium by HDBP, and of other metals by di-alkylphosphoric acids, over a wide range of conditions is discussed and compared with the mechanism of extraction of zirconium by tributyl phosphate (TBP) and by thenoyltrifluoroacetone (HTTA). (auth)

132 (CU-755-4) SEPARATION OF ISOTOPES. Annual Progress Report. (Columbia Univ., New York. Dept. of Chemistry). Sept. 20, 1967. Contract AT(30-1)-755. 343p. Dep. CFSTI.

Eight papers are included in five sections; separate abstracts were prepared for 6. The remaining two papers on concentration of ^{13}C and ^{18}O by the exchange of CO_2 and amine carbamates in a solvent carrier system and concentration of D by the exchange between methylacetylene and water in a dual-temperature system contain only brief information that is included in the other papers. (P.C.H.)

For abstracts of individual papers see: 133–138.

133 (CU-755-4, Paper IIB) SOLVENT CARRIER METHOD FOR THE SEPARATION OF ^{13}C AND ^{18}O ISOTOPES BY CHEMICAL EXCHANGE OF CARBON DIOXIDE WITH AMINE CARBAMATES IN NON-AQUEOUS SOLUTIONS. Agrawal, Jittendra P. (Columbia Univ., New York. Dept. of Chemistry). 133p.

By means of a capillary contacting flow apparatus it was demonstrated that the rate of exchange of ^{18}O between CO_2 and its reaction products with organic amines was faster by at least a factor of 10 in non-aqueous solutions than in aqueous solutions. In methanol solutions the three most effective amines were: isobutyl > monoethanol ≥ n-butylamine and the optimum operating conditions were molarity, 1.2 to 1.5 M; flow rate, ~0.8 ml/cm^2-min. In 1 M solutions hemin and cupric chloride were found to catalyze the enrichment of ^{18}O and ^{13}C. The isotopic separation by the exchange between CO_2 and its carbamate with n-butylamine in methanol was investigated in detail. The overall separations attained a maximum value in 1.0 to 1.2 M region. Studies above and below room temperature for both n-butyl and isobutyl amines indicated that the room temperature was the optimum temperature for the overall separations. From a commercial standpoint it was indicated that both ^{18}O and ^{13}C can be enriched in a single system. (P.C.H.)

134 (CU-755-4, Paper IIIC) SUMMARY OF RESULTS OF THE DUAL-TEMPERATURE PROCESS FOR CONCENTRATING DEUTERIUM BY THE METHYLACETYLENE AND THE HYDROGEN SULFIDE EXCHANGE REACTIONS WITH WATER. Goldfrank, Jack C. (Columbia Univ., New York. Dept. of Chemical Engineering). 41p.

A comparison was made of results on the dual-temperature process for concentrating deuterium using methylacetylene and hydrogen sulfide exchange reactions with water. Only a small percent of deuterium enrichment was found when methylacetylene was used: at most only 19.1%. This was very small in comparison to the 120.7% enrichment obtained with H_2S. It was found that the hydroxide ion catalyzes the methylacetylene–water isotope exchange reaction, which confirmed the fact that the reaction occurs in the liquid phase. A computer program was written to compute the number of theoretical plates in the hot and cold columns in accordance with the McCabe-Thiele method of stepping off theoretical plates. Data are tabulated. (P.C.H.)

135 (CU-755-4, Paper IIIB) RESEARCH PROPOSAL: SEPARATION OF HEAVY WATER UTILIZING THE ISOTOPE EXCHANGE REACTION BETWEEN METHYLACETYLENE AND WATER. Goldfrank, J. C. (Columbia Univ., New York. Dept. of Chemical Engineering). 59p.

A method for the separation of heavy water by a dual temperature system using the isotope exchange reaction $CH_3C \equiv CH + HDO \rightleftharpoons H_2O + CH_3C \equiv CD$ is proposed. The dual temperature system is based on the principle that the equilibrium constant K of an isotope exchange reaction changes with temperature. An advantage of this system is that the process equipment consists entirely of towers and heat exchangers that are of standard design. (P.C.H.)

136 (CU-755-4, Paper IV) PREPARATION OF 99.5 PERCENT NITROGEN-15 BY CHEMICAL EXCHANGE BETWEEN OXIDES OF NITROGEN IN A SOLVENT CARRIER SYSTEM. Jeevanandam, M.; Taylor, T. I. (Columbia Univ., New York. Dept. of Chemistry). 63p.

The distribution of ^{15}N between gaseous oxides of nitrogen and their solutions in a number of solvents at several temperatures was investigated for the $NO-N_2O_3$ exchange system. Using a spectrophotometric method of analysis for NO_2 in the gas phase along with known equilibrium constants and material balances, the compositions of the gas and liquid phases were determined both with and without solvents. It was found that the solvents decreased the concentrations of the N_2O_3, N_2O_4, and NO_2 in the gas phase and increased N_2O_4 in the liquid phase. A solvent carrier system was devised to take advantage of the increase in the single-stage fractionation factor, α, that results from the presence of a solvent. A cascade of two columns with a total length of 5.5 m was constructed for the preparation of 99.5% ^{15}N. The concentration reached 50% in 8 days, 90% in 12 days, and 99.5% in 17 days. (P.C.H.)

137 (CU-755-4, Paper V) HOLD UP OF LIQUID PHASES ON PACKING MATERIALS FOR EXCHANGE COLUMNS. Fecho, Gregory; Zia, William; Taylor, T. I. (Columbia Univ., New York. Dept. of Chemistry). 12p.

Studies were made on the holdup of exchangeable material on the packing of an exchange column. The volume of the liquid phase held by the packing as a function of flow rate was measured, and the effect of counter flow of a gas phase was determined. The results with CCl_4 showed that the counterflow of gas (in this case nitrogen) does not greatly affect the holdup. Also, the holdup was increased by only about 25% for a decrease of 36°C in the temperature. The results will be useful in analyzing the effects of flow rates on the overall separation of isotopes in exchange columns. (P.C.H.)

138 (CU-755-4, Paper VI) SEPARATION OF THE ISOTOPIC MOLECULES OF NITRIC OXIDE BY GAS CHROMATOGRAPHY. Smith, Jessie G.; Taylor, T. I. (Columbia Univ., New York. Dept. of Chemistry). 8p.

Studies were made on the separation of various isotopic forms of nitric oxide by low-temperature gas chromatography using columns packed with glass beads and Molecular Sieve 5A baked

at 120 or 325°C. The results indicated that adsorbents less active than molecular sieves, but more active than glass beads, should be investigated. Retention times and temperature are also discussed. (P.C.H.)

139 (HMI-B-54) BEITRAEGE ZUR KENNTNIS UND ZUR KERNTECHNISCHEN ANWENDUNG KRISTALLINER SILICAT-IONENAUSTAUSCHER. (Studies on the Behavior of Crystalline Silicate Ion Exchangers and their Application in Nuclear Technology). Levi, H. W. (Hahn-Meitner-Institut fuer Kernforschung, Berlin (West Germany)). Oct. 1967. 126p. (In German). Dep.

The mobility of alkali metal and alkaline earth ions in vermiculite, montmorillonite, and synthetic zeolites and their effect on the ion-exchange behavior of these materials were studied. Particular attention is given to the phenomenon of fixation. Practical applications for production of radionuclides and the treatment of radioactive wastes are discussed. (auth)

140 (JINR-D6-3281) EXPERIMENTS ON CHEMISTRY OF ELEMENT 104: KURCHATOVIUM. 1. DEVELOPMENT OF A METHOD FOR INVESTIGATION OF SHORT-LIVED ISOTOPES. Zvara, I.; Chuburkov, Yu. T.; Zvarova, T. S.; Caletka, R. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Reactions). 1967. 19p. Dep.

Physicochemical principles were investigated in a method for continuous separation and rapid chemical identification of isotopes of some transition elements produced in nuclear reactions by heavy ions. The method is based on the different volatilities of separated anhydrous chlorides of the elements and on different adsorbabilities of their molecules on solid surfaces. By performing experiments on separation of hafnium from lanthanide element isotopes and other products of nuclear reactions, conditions were chosen for comparison of element 104 properties with those of hafnium, known transplutonium elements, and other elements. (auth)

141 (JUL-502-RG-RW) HIGH TEMPERATURE VOLATILIZATION OF NEODYMIUM FROM THORIUM CARBIDE PARTICLES. Podo, L. A.; Nickel, H. (Kernforschungsanlage, Juelich (West Germany)). Sept. 1967. 21p. Dep.

Substantial decontamination of thorium carbide from isotopes of neodymium was obtained by heating under vacuum at temperatures in the range from 2000 to 2800°C. Sol-gel processes were adopted to prepare spherical thorium carbide particles containing 200 or 1000 ppM of neodymium. ^{147}Nd ($\tau_{\frac{1}{2}}$ = 11.1 d, γ = 0.53 MeV) was used as a tracer for radiometric determinations. (auth)

142 ION EXCHANGERS CONTAINING PHOSPHORUS IN THEIR FUNCTIONAL GROUP. APPLICATION OF THE SELECTIVE SORPTION PROPERTIES OF THESE EXCHANGERS TO QUANTITATIVE SEPARATIONS OF URANIUM, THORIUM, AND SOME OTHER ELEMENTS. Marhol, Milan (Nuclear Research Inst., Czechoslovak Academy of Science, Rez). Z. Anal. Chem., 231: 265-72(1967).

Uranium or thorium separations from a number of various ions were studied by means of cation exchangers containing phosphorus in their functional group. These ion exchangers adsorb selectively only UO_2^{2+} or Th^{4+} ions from the mixture studied in a medium of >0.4 N nitric or hydrochloric acid. Several di- and trivalent cations are not sorbed under these conditions. In the absence of UO_2^{2+} and Th^{4+} ions, Me^{2+} may be more easily separated quantitatively from Me^{2+} in 0.2 N nitric or hydrochloric acid than with cation exchangers containing the $-SO_3H$ group. (auth)

143 GAS CHROMATOGRAPHIC STUDIES OF ISOTOPICALLY LABELLED ETHYLENES. Atkinson, J. G.; Russell, A. A.; Stuart, R. S. (Merck Sharp and Dohme of Canada Ltd., Montreal). Can. J. Chem., 45: 1963-7(Sept. 1967).

The use of long, silver nitrate–ethyleneglycol gas chromatographic columns permitted a near base line separation to be achieved for deuterated olefins differing by only one deuterium atom. All of the six deuterated ethylenes and two deuterated butenes have been studied, and good separations have been obtained between the different isotopic species. The isotope effects (K_D/K_H) on the retention times have been calculated. Evidence of a difference in the relative retention times of two of the ethylene-d_2 isomers is presented for the first time. It has been demonstrated that the isotopic content of deuterated olefins can be determined by quantitative analysis with the same accuracy as by mass spectral analysis. A careful study of ethylene-^{13}C failed to reveal an observable isotope effect on its retention time relative to light ethylene. (auth) (UK)

144 VOLATILIZATION OF POLONIUM FROM BISMUTH OXIDE. Hasty, R. A. (Battelle-Northwest, Richland, Wash.). J. Inorg. Nucl. Chem., 29: 2679-84(Nov. 1967).

The volatilization of polonium from bismuth oxide was measured by a transport method between 580 and 780°C. The apparent vapor pressure, π, which is defined as the observed partial pressure of polonium divided by the mole fraction of polonium in bismuth oxide, was found to be represented by $\log \pi(\text{atm}) = -15.51 \times 10^3/T + 11.83$ over a mole fraction range of polonium between 10^{-6} to 10^{-5}. A comparison was made of the measured apparent vapour pressure with the partial pressure of polonium in the polonium–bismuth system and the vapour pressure of pure polonium metal. (auth) (UK)

145 INFLUENCE OF TEMPERATURE ON TRACER-LEVEL SEPARATIONS BY ION EXCHANGE CHROMATOGRAPHY. Dybczynski, Rajmund (Inst. of Nuclear Research, Warsaw). J. Chromatogr., 31: 155-70(Nov. 1967).

The effects of temperature on the separation of trace amounts of substances by ion exchange chromatography is discussed. The overall influence of temperature on the final resolution of chromatographic peaks consists of corresponding contributions due to the changes of separation factor and of plate height. Both separation factor and plate height can either decrease or increase or remain constant with a rise in temperature depending on the species to be separated and the ion exchange system employed. A general classification of possible changes in resolution resulting from the variation of separation factor and plate height is given, and numerous examples are presented. (auth)

146 SEPARATION AND DETERMINATION OF ZIRCONIUM IN NIOBIUM USING METHYLENEBIS(DI-n-HEXYLPHOSPHINE OXIDE). Kamin, George J.; O'Laughlin, Jerome W.; Banks, Charles V. (Iowa State Univ., Ames). J. Chromatogr., 31: 292-5(Nov. 1967).

A method is described for the separation of small amounts of niobium and zirconium by extraction chromatography using methylenebis(dihexylphosphine oxide), (MHDPO), as the stationary phase and hydrofluoric acid as the mobile phase. Filter paper impregnated with MHDPO was used in the paper chromatographic studies. Niobium was determined using the sulfuric acid–hydrogen peroxide spectrophotometric method. Zirconium was determined using the xylenol orange spectrophotometric technique. Results indicated that a clean separation of niobium and zirconium was obtained. Replicate analyses produced acceptable precision. (J.G.B.)

147 STUDY ON THE SOLVENT EXTRACTION WITH RADIO-TRACERS. II. SOLVENT EXTRACTION OF ^{210}Po FROM IRRADIATED BISMUTH WITH TRI-n-BUTYL PHOSPHATE. Chen, Ying-Mao (National Taiwan Univ., Taipei, China). J. Chin. Chem. Soc. (Taiwan), 13: 82-9(June 1966).

An extraction study of polonium from large amounts of irradiated bismuth was made with dilute TBP solution. The polonium used was ^{210}Po, which was prepared by the irradiation of bismuth according to the following nuclear reaction, $^{209}Bi(n,\gamma)\ ^{210}Bi^{\beta} \rightarrow {}^{210}Po^{\alpha} \rightarrow {}^{206}Pb$. It was found that extraction from 7 N HCl was most suitable, TBP concentration of about 10% was most effective, and with various kinds of the solvent as diluent, the order of the extraction was o-xylene > carbon tetrachloride > benzene > amyl alcohol > chloroform. More than 85% of polonium was extracted with 10% TBP in o-xylene from 7 N HCl solution, with a single extraction. Under these conditions only a negligible amount of bismuth was extracted. From the study of the distribution coefficients dependence on the variation of the concentration of TBP or acidities, the species extracted by the organic layer was considered to be $PoCl_4 \cdot 2TBP$ when TBP concentration was less than 50% TBP, but $PoCl_4 \cdot TBP$ when larger than 50% TBP. (auth)

148 AN INTRODUCTION TO FUEL PROCESSING. Power Reactor Technol. Reactor Fuel Process., 10: 59-60(Winter 1966-67).

Review articles on reactor fuel processing are listed. (27 references). (M.C.G.)

149 RECENT DEVELOPMENTS IN AQUEOUS PROCESSING. Stevenson, C. E.; Paige, D. M. Power Reactor Technol. Reactor Fuel Process., 10: 61-9(Winter 1966-67).

Preparation of fuel for processing, mechanical processing, dissolution of fuels clad with SAP, leaching of ThO_2 and UO_2 from alumina beds, release of tritium and krypton in shear-leach preparation of ThO_2-UO_2 fuels, dissolution of Al–Pu alloy, thermal decladding, ion-exchange processes, plutonium partition on silica gel, processing of $BeO-PuO_2-UO_2-UO_3-ThO_2$ fuel, extraction separation of americium and curium, plant and equipment design and operation, solids-removal devices, and stacked-clone contactors are discussed. (25 references). (M.C.G.)

150 VOLATILITY PROCESSES. Barghusen, J. J. Power Reactor Technol. Reactor Fuel Process., 10: 70-8 (Winter 1966-67).

Research progress is reported on volatility processes for highly

enriched fuels; chloride-volatility reprocessing of UO_2-PuO_2 fuel; fluoride-volatility reprocessing of UO_2-PuO_2 fuel; fluid-bed fluorination with F_2, ClF_3, or BrF_5; pilot plant design studies; corrosion in fluoride-volatility processes; safety aspects and environmental contamination control; and binary phases involving UF_6. (40 references). (M.C.G.)

151 COMPACT PYROCHEMICAL PROCESSES. Johnson, T. R. Power Reactor Technol. Reactor Fuel Process., 10: 79-84(Winter 1966-67).

Pyrochemical techniques for fuel processing are considered. Salt-transport processes for removal of fission products, oxide reduction, salt-transport studies with thorium, electrodeposition of uranium and plutonium oxides from a molten-salt bath, operation of the EBR-II fuel cycle facility, skull-reclamation process, and preparation of metals by reduction of their compounds are discussed. (29 references). (M.C.G.)

152 PROGRESS IN WASTE-DISPOSAL RESEARCH AND DEVELOPMENT. Fineman, Philip. Power Reactor Technol. Reactor Fuel Process., 10: 85-92(Winter 1966-67).

Treatment of low-level-activity wastes, tank storage of high-level-activity wastes, temperatures of buried waste-storage tanks and of soil near leaks in the tank, conversion of high-level-activity wastes to solids, radiant-spray calciner and melter, conversion to glass, fission-product recovery, corrosion in waste processing, and recovery of $Al(NO_3)_3$ from Redox acid waste are discussed. (33 references). (M.C.G.)

153 CRYSTALLINE INSOLUBLE SALTS OF POLYBASIC METALS. IV. CHROMATOGRAPHY OF INORGANIC IONS ON (SUPPORT-FREE) CERIUM(IV) PHOSPHATE SHEETS. Alberti, G.; Massucci, M. A.; Torracca, E. (CNEN, Rome. Univ., Rome). J. Chromatogr., 30: 579-83(Oct. 1967).

Fibrous cerium(IV) phosphate, a synthetic inorganic ion exchanger exhibiting a high ion exchange capacity, was employed to prepare completely inorganic ion exchange papers. The chromatographic behavior of several inorganic ions on pure cerium(IV) phosphate papers and on cellulose-cerium(IV) phosphate papers was examined and discussed. $HClO_4$ at various concentrations was employed as eluent. Considerable differences in the R_F values of various ions were found and some interesting separations are reported. (auth)

154 SOME PROPERTIES OF MINERAL ACID SOLUTIONS IN TRI-n-BUTYL PHOSPHATE AS FUNCTIONS OF WATER CONCENTRATION. Biddle, P.; Coe, A.; McKay, H. A. C.; Miles, J. H.; Waterman, M. J. (Atomic Energy Research Establishment, Harwell, Eng.). J. Inorg. Nucl. Chem., 29: 2615-27(Oct. 1967).

Thermochemical, viscosity, and electrical-conductivity measurements were made on the binary systems comprising TBP (tri-n-butyl phosphate) and a mineral acid ($HClO_4$, HCl, HNO_3 or H_2SO_4), and on the ternary systems comprising TBP, a mineral acid, and water. The energies of hydrogen bonding between TBP and HCl, HNO_3, H_2SO_4, or H_2O were calculated from the results, and the degrees of ionization of the acids were estimated. Earlier data on the ternary systems derived by equilibration with an aqueous phase were reviewed and corrected. The results are generally explicable in terms of species postulated previously. (auth) (UK)

155 GAS CHROMATOGRAPHIC SEPARATION OF POLAR ISOTOPIC MOLECULES. Cartoni, G. Paolo; Liberti, Arnaldo; Pela, Alberto (Univ., Naples). Anal. Chem., 39: 1618-22(Nov. 1967).

Polar isotopic molecules may be separated by gas chromatography providing efficient columns are used and operating conditions critically established. Glass capillaries, where a thin layer of carbon obtained from pyrolysis of methylene chloride is deposited, may be coated with polar stationary phases and yield columns of high resolution. The separation of the following polar compounds from their deuterium-substituted molecules was performed: $CH_3OH-CD_3OH \cdot C_2H_5OH-C_2D_5OH$; $CH_3COCH_3-CD_3COCD_3$, and $CHCl_3-CDCl_3$. The values of enthalpy and entropy changes relative to the chromatographic process obtained on various liquid phases (Ucon, triethylene glycol, squalane) were determined. The solute–solvent interaction of polar deuterated compounds is different from the corresponding hydrogenated compounds, and the magnitude of this interaction is strongly affected by the polarity of the liquid phase. The influence of the temperature and of the nature of the stationary phases on the isotopic effects for various systems examined is discussed and interpreted. (auth)

156 THE AMALGAMATION BEHAVIOR OF HEAVY ELEMENTS. 2. DIPOSITIVE STATE OF MENDELEVIUM. Maly, Jaromir; Cunningham, Burris B. (Univ. of California, Berkeley). Inorg. Nucl. Chem. Lett., 3: 445-51(Oct. 1967).

Preliminary results are reported concerning the extraction of Md into sodium amalgam from sodium acetate solution, and the possibility of a one-step electrolytic separation of mendelevium from einsteinium in citrate–acetate solutions, together with observations concerning the potential of the $Md^{3+} + e = Md^{2+}$ couple. (auth) (UK)

157 RADIOCHEMICAL SEPARATIONS BY ADSORPTION ON MANGANESE DIOXIDE. Bigliocca, Carla (CCR-EURATOM, Ispra, Italy); Girardi, Franco; Pauly, Jules; Sabbioni, Enrico; Meloni, Sandro; Provasoli, Augusto. Anal. Chem., 39: 1634-9 (Nov. 1967).

The adsorption behavior of 61 radioactive ions on especially prepared manganese dioxide from 0.1M HNO_3 solutions was studied by batch equilibrations and passage through chromatographic columns. No definite trend was evident among elements of similar chemical behavior. Many possible applications in the field of activation analysis, fission product studies, and separation of parent–daughter couples are described. (auth)

158 PRECIPITATION OF BERYLLIUM FROM HOMOGENEOUS SOLUTION BY DECOMPOSITION OF AN ACETYLACETONE SPECIES IN BASIC SOLUTION. Boyle, Walter G.; Otto, Charles H. Jr. (Univ. of California, Livermore). Contract W-7405-eng-48. Anal. Chem., 39: 1647-9(Nov. 1967). (UCRL-70194).

When one to two moles of acetylacetone were combined with one mole of beryllium, a chelate formed that was relatively soluble in water. This species held beryllium in solution even in quite basic media, but on heating the species was destroyed and beryllium hydroxide precipitated from homogeneous solution. The analytical characteristics of the beryllium hydroxide was improved when precipitated from a homogeneous solution. The precipitate filtered and washed very easily; however, it was still necessary to ignite the precipitate at 1150°C and in this respect it was similar to the usual NH_4OH precipitate. The homogeneous precipitate exhibited the unusual property of a large expansion in its apparent volume when ignited. The beryllium hydroxide produced by NH_4OH shrinks enormously when ignited. Results of precipitations from homogeneous solution at various concentrations of beryllium show a relative standard deviation of about 0.1%. The effect of impurities and the use of EDTA as masking agent for the impurities are discussed. It was also possible to produce condensed precipitates of Mg and U by decomposing the acetylacetone complexes in basic solutions. (D.H.M.)

159 THE BEHAVIOR OF SOLUBLE METALLIC POLYPHOSPHATES IN THE PRESENCE OF ION EXCHANGERS. IV. THE SEPARATION OF CERIUM(IV) FROM COBALT(II) AND COPPER(II) WITH CATIONITES. Ripan, Raluca; Stanisav, Costa (Univ. Babes-Bolyai, Cluj). Chim. Anal. (Paris), 49: 469-72(Sept. 1967). (In French).

The chromatographic behavior of soluble polyphosphates of cerium(IV), cobalt(II), nickel(II), and copper(II) was studied. These are obtained by treating the soluble salts of these ions with an excess of sodium polyphosphate, Graham's salt. By passing these polyphosphates through a chromatographic column with Dowex 50 Wx12 (H), the cerium(IV) polyphosphate passes quantitatively in the eluate and the cerium(IV) is determined by iodometry. The other polyphosphates are decomposed and the corresponding metallic ions are completely retained on the column. The cerium(IV) is thus separated from the cobalt, nickel, and copper ions by using sodium polyphosphate as a sequestrant. The reaction occurs in function of the H_2SO_4 concentration of the solution. The bivalent elements are eluated with HCl (10%) and determined with EDTA in the presence of murexide. The accuracy is ±0.6%. (auth)

160 SOLVENT EXTRACTION OF THALLIUM(III). Gupta, S. S.; Mukerjee, D. (Univ. of Lucknow, India). Chim. Anal. (Paris), 49: 449-51(Sept. 1967). (In French).

Thallium(III) was extracted from La^{3+}, Zr^{4+}, Th^{4+}, and UO_2^{2+} ions by using glycine as chelating agent and 10% phenol solution in petroleum ether as solvent at pH 1.5; 88 to 93% extraction was possible. The effect of pH on the extraction was also observed. Above 11% Ag, 10% Hg, 11% Cd, 7% Bi, 11% Ti, 28% Mn, 35% V^{5+}, 66% Be, 45% W, 35% Mo, and traces of a few elements interference was found. The results were reproducible and the method gave a coloring test specific for Tl^{3+}. Comparisons with the standard literature methods were made. (auth)

161 USE OF SPACERS FOR ELECTROPHORETIC SEPARATION OF RADIOACTIVE SODIUM AND POTASSIUM IONS. Vestermark, A. (Univ. of Stockholm); Wiedemann, B. Nucl. Instrum. Methods, 56: 151-3(Nov. 1967).

Metal ions have been concentrated and ordered into consecutive zones by electrophoresis on cellulose thin layers. By adding substances with the appropriate mobility, called spacers, the distance

between zones may be regulated, thus facilitating separation of groups of ions. This separation process is described for radioactive sodium and potassium ions. (W.H.K.)

162 GRAFT COPOLYMERS AS SUBSTRATES IN COLUMN EXTRACTIONS. I. NON-CHROMATOGRAPHIC SEPARATIONS ON EXTRACTION COLUMNS. Hornbeck, Robert F. (Univ. of California, Livermore). Contract W-7405-eng-48. J. Chromatogr., 30: 438-46(Oct. 1967). (UCRL-70151(Pt.1)).

Liquid-liquid extractions based on systems consisting of an aqueous solution and an organic complexing agent were adapted to column operation by the use of graft copolymers, which are both hydrophilic and organophilic as column supports. Columns were made and evaluated using graft copolymers of styrene and various hydrophilic polymers as substrates with complexing agents such as di-(2-ethylhexyl) orthophosphoric acid (HDEHP), N,N′,N″-trihexyl phosphorothioic triamide (thio-THPA), and 4-sec.-butyl-2-(α-methylbenzyl)phenol (BAMBP) as the adsorbed organic species. An improved column support was developed by irradiating polytrifluorochloroethylene (Kel-F) in a slurry with a styrene–methanol solution of polyethylene glycol compound. (auth)

163 GRAFT COPOLYMERS AS SUBSTRATES IN COLUMN EXTRACTIONS. II. CHARACTERISTICS OF HYDROPHILIC-ORGANOPHILIC COLUMNS IN CHROMATOGRAPHIC SEPARATIONS. Hornbeck, Robert F. (Univ. of California, Livermore). Contract W-7405-eng-48. J. Chromatogr., 30: 447-58(Oct. 1967). (UCRL-70151(Pt.2)).

The operating characteristics of extraction columns made from graft copolymers containing an adsorbed complexing agent are described by expressions analogous to those developed for ion-exchange resins. Several kinds of graft copolymers are compared, and guidelines developed for optimizing column resolution. The trivalent lanthanides are known to be eluted in order of increasing atomic number by gradient elution with hydrochloric acid on a column containing adsorbed di-(2-ethylhexyl) orthophosphoric acid (HDEHP). Adaptation of the plate equilibrium theory enables ϕ^*, the volume of effluent to maximum metal ion concentration, to be calculated from the expression $\int_0^{\phi^*} f^2(\phi)d\phi = Q^2V_iK$ where $f(\phi)$ is a term for the hydrogen ion concentration as a function of the volume of effluent, Q is a variable related to the concentration of the HDEHP, V_i is the effective interstitial volume of the column, and K is the equilibrium constant for the exchange reaction $[M^{3+}]_{aq} + 3[(HDEHP)_2]_{org} \rightleftharpoons \{M[H(DEHP)_2]_3\}_{org} + 3[H^+]_{aq}$. (auth)

164 CONTINUOUS SORPTION–DESORPTION SYSTEM AND METHOD. Brater, Donald C.; Dykstra, J. Jr.; Kaufman, H. L.; Smiley, S. H. (to U. S. Atomic Energy Commission). U. S. Patent 3,350,848. Nov. 7, 1967.

The selective recovery of UF_6 from a mixture of gases was investigated. UF_6 recovery was achieved by utilizing a sorption–desorption system in which particulate sodium fluoride was used to sorb the UF_6 and was continually circulated through the system while being subjected to successive and continuous sorption–desorption cycles. (AEC)

165 SEPARATION OF CERIUM FROM OTHER RARE EARTHS. Bray, Lane A.; Roberts, Francis P. (to U. S. Atomic Energy Commission). U. S. Patent 3,351,424. Nov. 7, 1967.

Cerium was separated from a radioactive aqueous solution containing rare earths by coextracting cerium and lanthanide rare earth values into a dialkyl phosphoric acid. The organic was separated from the aqueous phase and the lanthanides stripped, except for cerium, from the organic phase by contacting the organic phase with an aqueous solution 1 to 2 molar in mineral acid, 0.01 to 0.02 molar in silver ion, and about 0.2 molar in persulfate ion. (AEC)

166 NUCLEAR SAFE DISSOLVING APPARATUS. Faugeras, P.; Michel, P.; Talmont, A. (to Commissariat a l'Energie Atomique). Canadian Patent 758,513. May 9, 1967. Priority date July 22, 1963, France.

A subcritical dissolving apparatus designed for a maximum of the equivalent in fissile material of 1.5 kg of ^{239}Pu is described. It consists of a boiler, a phase separator, a dissolver of 4.5 liter volume, a condenser, and a solution tank (100 liter) situated below the level of the dissolver. Circulation velocity is controlled by the quantity of heat supplied to the boiler. It is claimed the geometry and flow rate are such that criticality cannot occur. (F.S.A.) (CANADA)

167 RECOVERY OF URANIUM FROM DILUTE CARBONATE SOLUTIONS. Pottier, P.; Macchiaverna, E. G. (to Commissariat a l'Energie Atomique. Comision Nacional de Energia Atomica). Canadian Patent 756,992. Apr. 18, 1967. Priority date July 11, 1963, France.

An anion exchange process is described in which high-purity ammonium uranyl tricarbonate was precipitated using a mixture of $(NH_4)_2CO_3$ and $NaHCO_3$ as the eluting solution. UO_3 or U_3O_8 may be readily obtained by heating between 250 and 500°C. (F.S.A.)

EARTH SCIENCES

Geology and Hydrology

Refer also to abstracts 15–22.

168 (CBA–1229–F4) FLOW OF GROUNDWATER AROUND NUCLEAR CRATERS. Lynch, Edward J.; Fielder, R. Richard; McFarlane, Robert C. (Bradberry (Carroll E.) and Associates, Inc., Los Altos, Calif.). June 25, 1965. 29p.

The flow of water through nuclear craters and canals was studied. Some quantitative results are presented for the rate of filling of a crater with water after the detonation, and the amount of water which will pass through the crater during the steady-state flow caused by the regional hydraulic gradient. Much more hydrologic field work needs to be done in order to establish the nature of the permeability variations in and around the crater. (auth)

169 (CEX–58.4.6) AERORADIOACTIVITY SURVEY AND AREAL GEOLOGY OF PARTS OF SOUTHEASTERN NEW YORK AND SOUTHERN NEW ENGLAND (ARMS–I). Popenoe, Peter (Geological Survey, Washington, D. C. Division of Biology and Medicine (AEC), Washington, D. C.). July 1963. 43p. Dep. mn. CFSTI $1.00 cy, $0.50 mn.

The results of a gamma-radiation survey of Connecticut, Rhode Island, and parts of New York, Massachusetts, New Hampshire, and Vermont indicate that a wide range of natural radioactivity exists and that the radioactivity is closely related to both the type of bedrock underlying glacial drift and to the glacial drift. Aero-radioactivity profiles were plotted from continuous scintillation detection measurements taken at 500 ft above ground during east-west flight traverses at 1-mile intervals. The bedrock of the area is described. The Quincy Granite of Rhode Island has the highest radioactivity of any rock (1500 counts per second). Rocks of higher than average radioactivity include the Storm King Granite, a south-central belt of the Hartland Formation and associated granitic gneiss, granitic gneiss in the cores of the domes of eastern Connecticut, and large areas of granitic gneiss in eastern Connecticut and Rhode Island. Rocks of lower than average radioactivity include the mafic and ultramafic rocks of the Cortlandt Complex, areas of metamorphic rock in the Housatonic and Berkshire Highlands, diabase and basalt of Triassic age, the plagioclase and amphibolitic gneiss of eastern Connecticut, the Glastonbury Gneiss north of Manchester, Conn., the Plainfield Formation, glacial lacustrine deposits in central Connecticut, and glacial outwash and marsh deposits on Long Island and in the Narragansett Basin. (auth)

170 (ORNL–IIC–10(Vol.2), pp 613–28) THE X-RAY EMISSION AND X-RAY DIFFRACTION QUANTITATIVE ESTIMATION OF CRYSTALLINE AND AMORPHOUS SiO_2 IN LAKE SEDIMENTS (LAGO DI MONTEROSI, NORTH OF ROME, ITALY). Cowgill, Ursula M. (Yale Univ., New Haven, Conn.).

A method is described for quantitatively estimating the various kinds of silicon compounds that exist in nature. The types normally found in lake sediments are the clay minerals, quartz and opal. The opal is of great interest, since the knowledge of its quantitative presence can provide an estimate of past diatom and chrysophycean populations that existed in the lake. The total quantity of silicon is determined by standard x-ray emission spectroscopic procedure. The amount of quartz, opal, and silicate of clay minerals is measured by the use of the wavelength shift from silicon to silicon dioxide on the one hand and to silicate on the other, employing the K_β line and using the same instrument. The standardization process here involves the simulation of both the organic and inorganic fraction of the matrix. The quantity of quartz is then estimated by x-ray diffraction techniques and is subtracted from the amount of quartz and opal. That portion of the silicon fraction that is neither opal nor quartz, for this material at least, may safely be considered the silicate of clay minerals in the sediment. The application of this method is shown in relation to samples from a core of the mud of Lago di Monterosi, a small crater lake north of Rome, Italy. Data for opal, quartz, and halloysite from these samples are presented. (auth)

171 (PHS–999–RH–26) NATURAL ENVIRONMENTAL RADIOACTIVITY FROM ^{222}Rn. Pearson, John E. (National Center for Radiological Health, Rockville, Md.). May 1967. 31p. Public Health Service Free.

Radium-226 and ^{222}Rn were measured using a de-emanation method in which the gaseous daughter, ^{222}Rn, is collected and analyzed by an alpha-scintillation method. "Emanating ^{226}Ra" from particles of soil in clay type soils varied from 0.342×10^{-12} grams per gram of dry soil to 0.690×10^{-12} grams per gram. Sandy soils varied between 0.147×10^{-12} to 0.244×10^{-12}. Highest activity measured was 14.3×10^{-12} grams of "emanating ^{226}Ra" per gram of dry soil containing uranium ore. Emanation from ground in Champaign County, Ill., for 216 measurements, was $(140 \pm 73) \times 10^{-18}$ curies of ^{222}Rn cm^{-2} sec^{-1}. Other soils released similar values of ^{222}Rn except at locations where ^{238}U is available in commercially significant amounts. Release of ^{222}Rn from the leaves of corn about midday and near the growth peak was approximately 2.6 times that of the soil under the corn at Argonne National Laboratory in one series of six tests. Radon-222 concentrations in the atmosphere were measured in eight series of 24-hour tests, to elevations of 16 m. Values of concentration at various times of the day are presented for the normal environmental levels. (auth)

172 TOTAL CARBON CONTENT AND PRIMORDIAL RARE GASES IN CHONDRITES. Otting, W.; Zaehringer, J. (Max-Planck-Institut, Heidelberg). Geochim. Cosmochim Acta, 31: 1949–60(Oct, 1967).

The total carbon contents of sixty-one chondrites were determined in the same specimens in which rare gas analyses were made. The carbon contents and the heavy primordial rare gas contents decrease from carbonaceous to enstatite to ordinary chondrites. A good correlation between carbon and rare gas content within the enstatite and the ordinary chondrites does not, however, exist. It was also found by stepwise oxidation that the primordial rare gases are not retained in carbon-containing phases. Most of the meteorites with high carbon contents were unequilibrated. The rare gases correlated better than carbon with the classification numbers of the subgroups. (auth) (UK)

173 ISOTOPIC COMPOSITION AND ABUNDANCE OF LITHIUM IN METEORITIC MATTER. Krankowsky, D.; Mueller, O. (Max-Planck-Institut fuer Kernphysik, Heidelberg). Geochim. Cosmochim. Acta, 31: 1833–42(Oct, 1967).

The isotopic composition of lithium and its elemental abundance were measured in the Bjurböle chondrite and the Essebi carbonaceous chondrite, as well as in chondrules of these meteorites, and in silicate and troilite inclusions of the Odessa octahedrite. The results were compared with those obtained for terrestrial granite G-1 and with the isotope ratio in diabase W-1. The $^7Li \cdot {}^6Li$ ratios agreed to within 2%. The lithium contents found for silicates in Odessa (1 · 3 and 1 · 9 ppM) were similar to the values measured for chondrites and chondrules. In two troilite samples of Odessa lithium concentrations of about 40 ppB were found. A lithium content of 21.9 ppM was measured in granite G-1. (auth) (UK)

174 HUGONIOT EQUATION OF STATE OF TWELVE ROCKS. McQueen, R. G.; Marsh, S. P.; Fritz, J. N. (Los Alamos Scientific Lab., N. Mex.). J. Geophys. Res., 72: 4999–5036(Oct. 15, 1967).

Shock-wave data have been obtained for the following rocks: one albitite, one anorthosite, two bronzitites, two diabases, two dunites, two eclogites, one granite, and one jadeite. The experimental pressure range is from slightly over 0.1 to about 1.0 Mb. There is evidence that all rocks investigated exhibit a phase change. It is estimated that the transformations occur at about 0.1 Mb for the low-density rocks and between 0.3 and 0.6 Mb for the high-density rocks. A single-shock Hugoniot consistent with the data has been determined for the high-pressure modification of some of these rocks. These equations of state are compared with similar equations of state derived from geophysical data for the earth. This comparison supports the model of a mantle composed of high-pressure modifications of these basic rocks with an iron content lying somewhere between that of Twin Sisters dunite and Hortonolite dunite. Other thermodynamic quantities have been calculated based on estimates of the specific heat and the Grüneisen parameter. (auth)

175 RUBIDIUM–STRONTIUM ISOTOPIC AGE MEASUREMENTS OF PLUTONIC IGNEOUS ROCKS IN EASTERN ELLSWORTH LAND AND NORTHERN ANTARCTIC PENINSULA, ANTARCTICA. Helpern, Martin (Southwest Center for Advanced Studies, Dallas). J. Geophys. Res., 72: 5133–42(Oct. 15, 1967).

Eastern Ellsworth Land plutonic igneous rocks intrusive into folded Jurassic sedimentary rock have been dated at 102 to 109 m.y. At Tisné point on the northwest coast of the Antarctic Peninsula, granodiorite is dated at 96 m.y. Ages are established with Rb-Sr isochrons using whole rock samples and biotite concen-

trates. A correlation between the igneous rocks of eastern Ellsworth Land and the Andean intrusive suite of the Antarctic Peninsula is deduced from similar trends in triangular variation plots of Fe-(K + Na)-Mg and K-Na-Ca. Field relationships, geochronology, and geochemistry indicate that Cretaceous plutonism of southern South America and of the Antarctic Peninsula extended at least as far south as Ellsworth Land and probably continued into the Ford Ranges near the Ross Sea. (auth)

Meteorology

Refer also to abstract 171.

176 (BNL-11800) MICROMETEOROLOGY OF THE TURBULENT FLOW FIELD IN THE ATMOSPHERIC SURFACE BOUNDARY LAYER. Singer, I. A.; Busch, Niels E.; Frizzola, J. A. (Brookhaven National Lab., Upton, N. Y.). Aug. 31, 1967. 50p. (CONF-670943-1). Dep. CFSTI.

From International Research Seminar on Wind Effects on Buildings and Structures, Ottawa, Canada.

The background for the Monin-Obukhov similarity hypothesis which describes the height dependence of various turbulent flow parameters in a thermally stratified surface boundary layer is outlined. The hypothesis can be regarded as a dimensional analysis assuming that gradients in the parameters are unique functions of the height of observation, the friction velocity, the vertical temperature flux, and the buoyancy parameter. Under simplifying assumptions the last three quantities can be shown to be constant with height and when combined into a characteristic length, time, and temperature, they can be used as scaling parameters for the flow. The implications of the hypothesis are discussed. A recent analysis of spectral data taken at Brookhaven National Laboratory under thermally neutral and unstable conditions is presented and compared with other analyses. The major conclusions were that: when plotted in similarity coordinates, the spectra of the longitudinal velocity components show no sign of dependence on thermal stability; within the accuracy of measurement, the spectra of the vertical velocity component obey similarity theory up to approximately 50 meters for moderate thermal instability; and the spectra of the lateral wind component are by far the most sensitive to changes in thermal stability and seem not to agree with similarity theories. Parameters other than those studied may strongly influence the shape of the spectra. The scale of the lateral turbulence is intermediate between the longitudinal and vertical scales. (auth)

177 (BNL-11848) ISOTOPIC RATIO TRACER TECHNIQUE. Smith, Maynard E.; Cohen, Lester A. (Brookhaven National Lab., Upton, N. Y.). Oct. 1967. 14p. (CONF-670931-15). Dep. CFSTI.

From USAEC Meteorological Information Meeting, Chalk River, Ontario, Canada.

The feasibility of utilizing naturally occurring differences in the stable isotopes of sulfur as a means of identifying SO_2 and sulfates with the major sources from which they originate is investigated. The technique involves sampling of the SO_2 from the atmosphere by a chemically treated filter, a series of chemical conversions and finally determination of the isotopic ratios in a mass spectrometer. The details of this tracer system and its initial field results are summarized. (auth)

178 (COO-382-76) [METEORITES]. Annual Progress Report, September 21, 1966-September 25, 1967. Anders, Edward (Chicago Univ., Ill. Enrico Fermi Inst. for Nuclear Studies). Sept. 25, 1967. Contract AT(11-1)-382. 8p. Dep. CFSTI.

Progress is reported on research on trace element abundance in chrondrites, ages of meteorites, cosmic dust in the deep sea estimated from the Ir content of sediments, and orbits of meteorites. Papers issued during this reporting period are listed. (F.S.)

179 (NYO-3654-3) PROJECT STREAK. Quarterly Progress Report No. 3. Seitz, Harold; Davidson, B.; Friend, J. P. (Isotopes, Inc., Westwood, N. J.). Sept. 30, 1967. Contract AT(30-1)-3654. 15p. Dep. CFSTI.

Several experiments on the injection of ^{90}Sr into the atmosphere from the 1961 and 1962 nuclear tests were conducted. Preliminary analyses of the results are presented. Preparation for the ^{7}Be testing of the model is continuing. The problem in the preparation of input of the distribution of equilibrium production rates of ^{7}Be was solved. Experiments were conducted to investigate the consequences of material injection close to the model boundary for testing high altitude injections. (F.S.)

180 (PEL-89) ENVIRONMENTAL RADIOACTIVITY AT THE NATIONAL NUCLEAR RESEARCH CENTRE, PELINDABA. Report Until End 1964. van As, D. (Atomic Energy Board, Pelindaba, Pretoria (South Africa)). July 1965. 75p. Dep.

Levels of environmental radioactivity found in and around Pelindaba, the site of the South African Fundamental Atomic Reactor Installation SAFARI-I, before reactor criticality was achieved are summarized. Natural γ radiation measurements; measurement of α and β activities in soil, river water, fish, fallout, air, and farm products; and the activities of the individual nuclides ^{137}Cs, ^{40}K, and ^{90}Sr are included. For the purpose of a relative comparison of background activity, the measurement of total β activity will give an indication of changes. In order to assess the importance of changes, energy of the β activity must be known. (F.S.)

181 (TAEC-D-5) TURKISH ATOMIC ENERGY COMMISSION THIRD ACTIVITY REPORT OF THE RADIOACTIVE FALLOUT LABORATORY, AUGUST 1965-JULY 1966. Senvar, C. B.; Ergin, M.; Usul, F.; Tugsavul, A.; Yazgan, E.; Saygili, N. (Atomic Energy Commission, Ankara (Turkey)). 1966. 12p. Dep.

The results of radioactivity measurements in air, milk, and rainwater, at Ankara, Turkey, for the period of August 1965 through July 1966 are reported. Measurements of uranium content and gross beta activities in hot springs are tabulated. The increase in radioactivity due to the third Chinese nuclear test of May 1966 is indicated. It is concluded that very little danger from radioactive fallout exists in Turkey, and that three hot springs have substantially high levels of uranium content. (L.C.L.)

182 (UCRL-50299) LONG-RANGE DIFFUSION OF THE NRX/EST EP-4A EFFLUENT CLOUD. Crawford, Todd V. (California Univ., Livermore. Lawrence Radiation Lab.). June 1967. Contract W-7405-eng-48. 49p. Dep. CFSTI.

The generation, movement, and diffusion of the effluent cloud produced by the NRX/EST EP-4A reactor experiment of March 25, 1966, are discussed. The meteorology data during the reactor run are presented and, in the absence of measurements, an estimate of the stabilized initial cloud height and size is made. Estimated cloud widths are consistent with data obtained from ground-mounted instrumentation. Based on radiosonde data, meteorological trajectories, and aircraft concentration measurements, the height and horizontal trajectory of the effluent cloud for two days following the reactor run is discussed. Initial size and time-dependent meteorological parameters along the trajectory are then used as input to a cloud diffusion calculation with 2BPUFF computer code. Comparison of calculations with data indicate agreement, within a factor of two, for air concentration out to two days, surface air concentration, dry deposition, vertical concentration profile shape, and cloud size. During the two days over which measurements and calculations are compared, the radioactive concentration at the cloud center decreased some seven orders of magnitude. (auth)

183 VARIATIONS, AT TOULOUSE, OF CONCENTRATIONS OF ^{210}Pb, ^{210}Po, AND ^{7}Be IN THE AIR AND PRECIPITATIONS. Marenco, Alain; Fontan, Jacques; Blanc, Daniel; Lacombe, Jean-Pierre; Huguet, Regis (Faculte des Sciences, Toulouse). Geofis. Meteorol. (Genoa), 16: 31-5(Jan.-Apr. 1967). (In French).

Since September, 1965, data were collected on the long-lived natural radioactivity of aerosols in the air and in rain (^{7}Be, ^{210}Pb, and ^{210}Po), as part of a study of some problems of the physics of the atmosphere. This necessitated special sampling equipment and a method of chemical separation, which are described. Some earlier work carried out in various countries is also considered. A discussion of the results is presented. Measurements made on rain, showed that the activities are linked to pluviometry. The homogeneity of air masses, with respect to the long-lived natural radioactivity, was confirmed by the identical results obtained at 2 different points of sampling. Seasonal variations were observed, and the influence of the pluviometry on the concentrations of the long-lived radioactive elements in the air is shown. Comparison of the activity in the air and in the precipitations showed some parallel variations. (BBB)

184 LEAD AND ^{210}Pb IN RAINWATER. ter Haar, G. L.; Holtzman, R. B.; Lucas, H. F. (Argonne National Lab., Ill.). Nature (London), 216: 353-4(Oct. 28, 1967).

Studies were carried out to evaluate the relationship between stable lead and ^{210}Pb in the atmosphere. Rainwater was selected as the medium for study since it samples a large volume of air at high altitudes, thereby minimising effects from local sources. Samples were collected at ANL and on a farm in Ottawa County, Michigan. Analysis showed that <10% of the lead was in the solids retained on the filters. Data are tabulated for materials in the soluble portion of the rain-out. Lead determination was by the standard spectrophotometric dithizone method. The ^{210}Pb was determined from the beta count rate of its ^{210}Bi daughter, employing an Al foil to prevent the alpha activity of ^{210}Po being counted. The mean lead concentration of 18.9 $\mu g/l$ at ANL was almost the

same as that in Michigan (17.4 μg/l), and the mean concentrations of ^{210}Pb were 1.26 and 1.78 pc/l, respectively. There appeared to be a correlation between the type of rainfall and the concentrations, but no correlation between lead concentration and length of time between rainfalls. The weather preceding a rainfall may, however, affect the concentrations. The rates of deposition at ANL were estimated at ~1 μg/cm^2/yr for stable lead, and 0.08 pc/cm^2/yr for ^{210}Pb. The data show that there is good mixing of stable lead and ^{210}Pb in the atmosphere, and that ^{210}Pb is a valid tracer for studies of residence time of stable lead in rainwater and perhaps in higher altitude air. A mean residence time of about 1 month for stable lead is indicated. (UK)

185 VARIATIONS IN THE ISOTOPIC COMPOSITION OF CARBON IN URBAN ATMOSPHERIC CARBON DIOXIDE. Friedman, L.; Irsa, A. P. (Brookhaven National Lab., Upton, N. Y.). Science, 158: 263-4(Oct. 13, 1967).

Measurement of the abundance of atmospheric carbon dioxide as an indicator of air pollution has been of very limited value because of variations in urban areas in the substantial concentration of natural carbon dioxide produced from combustion and noncombustion (natural) sources. A solution to this problem is the use of precise isotopic assay of ratios of carbon-13 to carbon-12 in atmospheric carbon dioxide. There is very little variation of carbon isotopic composition in samples taken over rural or urban areas where rapid mixing and diffusion of gaseous combustion products is possible. Significant differences in this composition in samples taken at centrally located points at street level in the lower Manhattan business district show an increase in concentration of atmospheric carbon dioxide of roughly 20% produced primarily by automobile exhaust. (auth)

186 IMPLICATIONS OF CHANGES IN THE GLOBAL ^{90}Sr BUDGET. Volchok, H. L.; Krey, P. W. (Health and Safety Lab., New York). J. Geophys. Res., 72: 5155-6(Oct. 15, 1967).

In late 1965 an inventory of the geographical and spatial distribution of ^{90}Sr was made for eleven time periods from August 1961 through March 1965. The method consisted of summing the ^{90}Sr contents of the stratosphere and the troposphere and the amount from fallout for each date. The totals were then compared with the amounts released into the atmosphere by announced nuclear tests. The results showed a deficiency in the observed inventory in every case, and that this deficiency had been increasing since the cessation of atmospheric nuclear tests at the end of 1962. Subsequently, substantial corrections in the estimates of stratospheric inventories were made as a result of the discovery of errors in the radiochemical analyses used. As a result, no substantial imbalance exists between the rate of stratospheric depletion of ^{90}Sr and its accumulation on the ground, and it is concluded that, since the end of 1962, no further unaccountable ^{90}Sr has appeared in the global budget. (L.C.L.)

187 FISSION PRODUCTS OF UNUSUAL COMPOSITION IN FINLAND. Kauranen, P. (Univ. of Helsinki); Kulmala, A.; Mattsson, R. Nature (London), 216: 238-41(Oct. 21, 1967).

A cloud of fresh highly fractionated fission products was observed in Finland between December 21st and 26th, 1966. These appeared to come from Central Asia, and were probably the product of an underground nuclear test. The β-activity, deposited through light precipitation of snow, amounted to about 10nCi/m^2 in southern Finland and to about 2nCi/m^2 in northern Finland. An autoradiograph of an air filter sample showed very homogeneous blackening of the film, and no hot spots were detectable such as were observed in nearly all previous samples in December (originating apparently from the Chinese nuclear test of October 27th); hence a new unknown source had to be considered. The β-activity appeared to be chiefly a mixture of ^{89}Sr and ^{140}Ba/^{140}La, with a ^{90}Sr/^{140}Ba activity ratio of 1.60, together with two additional β-emitters with half-lives of about 3 days and 20 to 40 days. The γ-peaks of the short-lived ^{140}Ba/^{140}La and ^{132}Te/^{132}I were immediately identified, and a small peak at 365 keV indicated the presence of ^{131}I. A short-lived peak at 280 keV was unidentified. In radiochemical analyses the 668 and 772 keV γ-peaks grew into the Te fraction, confirming that they represented ^{132}I. Peaks corresponding to the γ-energies of ^{141}Ce, ^{103}Ru and ^{137}Cs were visible after the short-lived activities had decayed. A sample of top layer snow showed ^{140}Ba, ^{89}Sr, ^{90}Sr, and ^{131}I. The presence of an appreciable amount of ^{132}Te in aerosol sample suggests that the debris had a rather short age. Based on the fact that ^{140}La was not in equilibrium with ^{140}Ba an age of 5.5 ± 0.7 days counted from December 23rd was obtained. Investigations of fractionation were based on ^{140}Ba as reference. The strongest enrichment was shown by ^{89}Sr and ^{137}Cs. ^{90}Sr was apparently enriched to a lower degree, while all other nuclides observed were depleted in relation to ^{140}Ba. The strong fractionation of the debris can be explained by assuming a sudden release of volatile fission products, such as would be expected from an underground nuclear detonation. Meteorological considerations strongly indicate a central Asian origin. Seismological information indicated an underground nuclear test in the Semipalatinsk area on December 18th, and this could have been the source of the reported activity. No health hazards were involved. (UK)

188 CONCENTRATIONS OF ^{7}Be OVER AUSTRALIA DURING 1965. Hicks, B. B. (CSIRO, Victoria, Australia). Nature (London), 216: 250-1(Oct. 21, 1967).

In an attempt to obtain more information concerning the behavior of the southern stratosphere the fallout research programme conducted by CSIRO was extended to include measurements on ^{7}Be, which is a radioisotope produced by cosmic rays and the atmospheric production rates of which have been thoroughly investigated. During 1965 a study was made of the tropospheric and stratospheric concentrations of ^{7}Be over eastern Australia. Air filters were exposed at altitudes between 5 and 30 km, and analysis was by gamma spectrometry. Results are tabulated. The most striking feature is the large discrepancy between the measured concentrations between 10 and 20 km and the predicted equilibrium values. The four means plotted are about twice the expected values. An obvious explanation lies in the disregard of stratospheric transport; mean motion or mixing might explain the observations. Assuming a mean motion model subsidence from greater heights and a drift towards the equator would be necessary, but studies with other tracers suggest that if such horizontal drift exists its direction is towards the poles. On the basis of a diffusion model the large concentrations of ^{7}Be observed in the lower stratosphere can only be explained by stronger mixing poleward of 42°S. Workers studying cosmic ray spallation products in the lower stratosphere have generally reported concentrations lower than predicted equilibrium values. It is intended to expand the programme to include other cosmic ray spallation products. (UK)

189 PROCEEDINGS: THE THIRD NATIONAL CONFERENCE ON AIR POLLUTION, WASHINGTON, D. C., DECEMBER 12-14, 1966. Public Health Service Publication No. 1649. Washington, D. C., Department of Health, Education, and Welfare, 1967. 683p. $4.25 GPO. (CONF-661214).

Sixty-three papers on air pollution problems in the United States are presented. A separate abstract was prepared for one paper. (L.C.L.)

For an abstract of the individual paper see: 190.

190 DEVELOPMENT OF NATIONAL POLICY WITH RESPECT TO NUCLEAR AND OTHER NEW SOURCES OF POWER. Seaborg, Glenn T. (Atomic Energy Commission, Washington, D. C.). pp 131-6 of Proceedings: The Third National Conference on Air Polution, Washington, D. C., Dec. 12-14, 1966. Washington, D. C., Department of Health, Education, and Welfare, 1967.

See CONF-661214.

The reduction of air pollution by the use of nuclear power plants instead of fossil-fueled power plants for electric power generation is discussed. Developments in nuclear power generation, including new reactors, controlled fusion, and MHD conversion, are described. Changes in government policies in regard to private nuclear power production are also described. (L.C.L.)

Oceanography

191 (TT-66-51029) OCEANOGRAPHIC RESEARCH IN THE ATLANTIC. Klenova, M. V. (ed.). Translation of Tr. Inst. Okeanol., Akad. Nauk SSSR, 56: 3-317(1962). 322p. (IPST-Cat.-1676). CFSTI.

Oceanographic research is presented in two groups of reports. The first section deals with the geomorphology of the North Atlantic continental shelf and with studies of the sediments and suspended matter in the Atlantic Ocean. The second section includes studies of heat, and salt flow and internal waves in the Atlantic Ocean, theory of the Antarctic circular current, and oceanographic studies in the Mediterranean Sea. (L.C.L.)

192 RADIUM AND RADIOCARBON IN CARIBBEAN WATERS. Szabo, B. J.; Koczy, F. F.; Ostlund, G. (Univ. of Miami, Fla.). Earth Planet. Sci. Lett., 3: No. 1, 51-61(Sept. 1967).

The measurements of vertical and areal distribution of radiocarbon, radium-226, and oxygen indicate that the deep water (>1500 m) of the Colombian and Venezuelan basins are not presently renewed. The renewal time of deep water in these basins is estimated between 50 and 400 years. The radium content is found to be rather uniform in the Venezuelan basin, 5.8×10^{-14} g/l; it varied between $4\text{-}6 \times 10^{-14}$ g/l in the Colombian basin. In

the Puerto Rico Trench radium content was found to increase with depth from 3.4×10^{-14} g/l at the surface to 8.0×10^{-14} g/l at 7400 m depth. (auth)

Seismology

193 (UCRL-Trans-10136) RESULTS OF SCIENTIFIC OBSERVATIONS DURING THE BLAST IN MEDEO. Aptikaev, F. F.; Gorbunova, I. V.; Dokuchaev, M. M.; (and others). Translated by J. Mulhaus for Univ. of California Lawrence Radiation Lab., Livermore, from Vestn. Akad. Nauk Kaz. SSR, 23: No. 5, 30-40(1967). 30p. Dep. CFSTI. JCL $3.60 fs, $1.13 mf.

A rock fill dam in a gorge of the River M. Almatinka, Russia, was created by conventional blasting of a mountainside. Scientific observations were made during the blasting to measure the seismic waves, motion of the blasted rock, and damage to dwellings in the vicinity. The method proved successful in creating the desired dam, gas-dust from the explosion was innocuous beyond a 1 km range, and ground shock waves did not damage dwellings 1100 meters away. The macroseismic effect of the blast proved less destructive at short distances than predicted. (L.C.L.)

194 MICROBAROGRAPH RECORD OF WAVES FROM THE CHINESE THERMONUCLEAR EXPLOSION ON JUNE 17, 1967. Jones, R. V. (Univ. of Aberdeen, Scotland). Nature (London), 215: 672(Aug. 5, 1967).

An unusual train of waves, characteristic of a distant and violent disturbance of the atmosphere, began to be received on a microbarograph in Aberdeen at about 0545 h G.M.T. on June 17, 1967. This train, which lasted about an hour, was superimposed on a much longer and more usual series of waves of period about 12 min and amplitude 250 microbars (such waves, which are of natural origin, are characteristically received during meteorological inversions). The unusual train is likely to have arisen from the first Chinese thermonuclear explosion, announced some hours later. Two small disturbances on a vertical seismograph were also recorded at Aberdeen at 0050 and 0147 h G.M.T. on the same day. If the earlier of these disturbances originated from the explosion, the range was about 4,000 miles, which is consistent with an origin in Western China. The peak-to-peak amplitude at Aberdeen of the largest atmospheric waves from the bomb was about 270 microbars. This may be compared with amplitudes at Aberdeen of 350 microbars and 1,000 microbars for the Russian explosions of 25 and 50+ megatons TNT equivalent over Novaya Zemlya on October 23 and October 30, 1961. Because the Chinese explosion was at roughly twice the range of Novaya Zemlya it appears to have been equivalent to that of between 20 and 30 megatons TNT. This figure is consistent with the 1.5 min period of the largest waves in the train. (auth)

195 ANALYSIS OF SURFACE-FOCI TRAVEL TIMES. Carder, D. S.; Gordon, D. W.; Jordan, J. N. (Coast and Geodetic Survey, San Francisco). Bull. Seismol. Soc. Amer., 56: 815-40(Aug. 1966).

Data from the Gnome, Bilby, and Salmon nuclear explosions and other data were used to determine surface foci seismic wave travel times for North America. Regional and teleseismic P wave travel times from surface foci entailed relatively fast crustal and upper mantle velocities beneath continental shields, and, in contrast, slow velocities beneath cordillera. On the average, teleseismic readings from continental and oceanic sources gave arrival times 2 sec earlier than the Jeffreys-Bullen (J-B) zero depth curve. In addition to this overall offset, an empirical surface focus curve showed prominent departures from the J-B predictions near 30° and 60°, where the observations were ~2½ to 3 sec earlier than the J-B curve. As defined here the term transition zone refers to the range from 12° to 18° (circa) where the first apparent arrival depends on signal-to-noise conditions. Given sufficient signal strength P_r, an emergent phase which fits a slope of 8.6 to 8.8 Km/sec on travel time plots, arrives first. Amplitudes associated with the P_t (P-teleseismic) phase dominate the longitudinal portion of recordings from the transition zone and, if noise levels are high, the observer often interprets P_t as the first arrival. (BBB)

196 A REAL TIME SEISMIC ARRAY DATA ANALYZER AND ITS ASSOCIATED EVENT SELECTOR. Hutchins, W. H. (Atomic Weapons Research Establishment, Aldermaston, Eng.). Radio Electron. Eng., 31: 293-308(May 1966).

The detection and identification of small underground nuclear explosions and earthquakes are difficult for 3 reasons. First, the amplitudes of the seismic signals are small at normal recording distances, and may be less than the level of the background seismic noise. Second, the signals are often complicated by the transmission path, and may contain many overlapping components. Third, even when isolated signal components of adequate signal-to-noise ratio are received, there remains the problem of applying criteria to determine whether they were produced by an earthquake or by an explosion. A specialized data processing machine is described which is capable of using data from an array of seismometers to derive information on the direction of arrival, phase velocity and energy-time distribution of body waves from distant seismic events. The organization and method of operation of the machine are described and reasons for the choice of system are discussed. A simplified correlator which automatically selects events from the background noise is also utilized. A description of this unit and some results obtained with it are presented. (BBB)

ENGINEERING

Nuclear Explosions

Refer also to abstracts 168, 195, 196, and 207.

197 (PNE–1104) CLOSE-IN GROUND MOTION, EARTH STRESS, AND PORE PRESSURE MEASUREMENTS. Project Pre-Gondola I: Cratering Site Calibration Series. Day, J. D.; Murrell, D. W.; Sherman, W. C. (Army Engineer Waterways Experiment Station, Vicksburg, Miss.). July 1967. 129p. Dep. CFSTI.

The objectives of this project were to measure and analyze the particle velocities, soil stresses, and pore water pressures produced by detonation of 20 tons of nitromethane in saturated clay-shale. The ground range of primary interest was 85 to 375 feet from surface ground zero with most instruments placed at shot depth (46.3 feet). Peak stresses were greater than estimated at the close-in locations (8,000 to 12,000 psi measured vs 5,000 psi predicted) and attenuated as the −2 power with distance. Particle velocities were consistently higher than predictions based on experience in other media. High amplitude transient pore pressures were produced by the explosion. Residual excess pore water pressures tended to drop off slowly with time. (auth)

198 (PNE–1108) CLOUD DEVELOPMENT STUDIES, Project Pre-Gondola I. Final Report. Day, Walter C. (Army Engineer Nuclear Cratering Group, Livermore, Calif.); Rohrer, Robert F. (California Univ., Livermore. Lawrence Radiation Lab.). July 1967. Contract W-7405-eng-48. 78p. Dep. CFSTI.

The clouds resulting from four 20-ton nitromethane cratering explosions in a wet clay shale medium were studied by photographic analysis and lidar (laser-radar) tracking. A technique for detecting tracers in future events in the same medium was investigated. It was found that the clouds were unique in that they were very diffuse (low particle density) and ceased to be visible within several minutes, there were no main clouds resulting from dynamic venting during mound rise, and steam was visible in the base surge clouds. Base surge radius dimensions observed were larger than those observed in basalt and smaller than those observed in alluvium. Base surge height dimensions were much larger than those previously observed in any medium due to the steam present in the cloud. Lidar tracking was successful and indicated its capability to provide information as a function of time on the position, motion, growth, and internal structure of cratering explosion clouds. Cloud sampling indicated that several elements including palladium, cadmium, indium, and europium are suitable for use as tracers in future chemical explosive cratering events at the Pre-Gondola I site. (auth)

199 (TID–23748) NUCLEAR CIVIL ENGINEERING OUTLINE SYLLABUS FOR CE 277 GIVEN WINTER QUARTER, 1966. Technical Report No. 70. Kruger, Paul (Stanford Univ., Calif. Dept. of Civil Engineering). Sept. 1966. Contract AT(04-3)-326. 330p. Dep. CFSTI.

A compilation of lecture notes for a course in Nuclear Civil Engineering at Stanford University based on progress achieved by the Plowshare Program in harnessing the power of nuclear explosives for peaceful purposes is presented. The lectures are grouped as follows: science and technology of contained and cratering nuclear explosives; experiences of the Plowshare Program; hazards from radioactivity, air blast, seismic shock, and groundwater contamination; and the potential applications in science, construction, water resource management, and geologic industries such as petroleum, gas, and mining. (F.S.)

200 TIME HISTORY OF THE CAVITY PRESSURE AND TEMPERATURE FOLLOWING A NUCLEAR DETONATION IN ALLUVIUM. Olsen, Clifford W. (Univ. of California, Livermore). J. Geophys. Res., 72: 5037-41 (Oct. 15, 1967).

The cavity pressure following a nuclear detonation in alluvium at the Nevada Test Site has been measured from about 45 sec until subsidence at 10.2 min. The pressure was found to follow the expression P (bars) = 36.7 $e^{-0.38t}$ + 7.8 for about 7 min. Such a pressure history corresponds to simple cooling of a steam-filled cavity with a surface heat-transfer coefficient of 0.012 cal/cm² sec °K. Original pressure, after the completion of cavity growth, was apparently overburden pressure. The difference between measured and calculated pressure after about 7 min can be explained as the result of condensation of the steam. After condensation begins, the pressure is simply the vapor pressure of water. The observed pressure is used to calculate the apparent rate of condensation and the necessary heat-transfer rate. The surface heat-transfer coefficient after the onset of condensation is found to be about 1 cal/cm² sec °K, a value that implies spalling of the cavity surface. (auth)

Facilities and Equipment

Refer also to abstracts 25, 233, 265, 1097, 1107, 1119, 1120, 1907, and 1933.

201 (AD–646555) PROGRAM 631A. VOLUME VI. EXPERIMENT D8: RADIATION IN SPACECRAFT. Schneider, Marion F.; Janni, Joseph F.; Brentnall, B. (Air Force Weapons Lab., Kirtland AFB, N. Mex.). May 1966. 272p. (SSD-TR-66-115). CFSTI.

Air Force Radiation Experiment D8, carried out as a part of the 631A Program on the NASA Gemini flights is described. This experiment was concerned with gathering dose data and developing techniques furthering the art of manned spacecraft radiation dosimetry systems. Information from D8 should be of significant value in ensuring manned mission safety and success in the future. From this effort new and highly sophisticated space-flight-worthy radiac systems have evolved. Their versatility in manned space operations was demonstrated for the first time on Gemini IV. D8 was the initial effort to place a complete dosimetry system onboard a manned spacecraft. This radiation experiment consisted of the latest available passive devices complimentary to (and correlated with) active ionization chambers giving instantaneous dose data. The information gathered in this experiment has been used to perform vital empirical checks on existing computational techniques and is presently providing corrections for application to theoretical prediction capabilities for radiation hazards associated with future manned spaceflights. (TAB)

202 (ANL–7343) EVALUATION OF MAGNETIC PULSE FORMING AS A JOINT FABRICATION TECHNIQUE FOR CP-5 FUEL ELEMENTS. Kuncl, L. G.; Hagemann, R. B.; Kotora, J. Jr. (Argonne National Lab., Ill.). June 1967. Contract W-31-109-eng-38. 29p. Dep. CFSTI

Magnetic pulse forming, a high-energy rate metal-working process, has been investigated and evaluated as a substitute fastening technique for fabricating CP-5 fuel elements. This process produces joints whereby aluminum tubing is magnetically swaged into machined aluminum casting grooves. A number of samples produced by this technique have been tested to destruction. Test results have compared favorably with the currently used welded joint. Visual and dimensional inspection of the samples revealed a high degree of constructional uniformity. The tensile- and compression-test results have shown consistently high strength. The joints were unaffected by thermal cycling in the temperature range simulating the operating environment of the reactor. Higher temperatures, over 600°F, caused a strength reduction of about 40%, but the joint strength was still more than adequate for the CP-5 reactor application. Because of the high strength of the joint, the consistency of this strength over many samples, and the economics inherent in the simple fabrication and inspection techniques, the magnetic-pulse-formed joint appears to be a desirable and feasible fastening method for CP-5 fuel-element joints. (auth)

203 (CONF-661011, pp 104-14) MEASUREMENT OF HETEROGENEOUS MIXTURES OF SCRAP USING DIFFERENT TECHNIQUES. Panel Discussion.

The processes used for measuring plutonium or uranium content in heterogeneous scrap are discussed. Percentage errors for the techniques are given. J.C.W.)

204 (N–67-18419) STUDY OF SOLID-STATE INTEGRATED MICROWAVE CIRCUITS. Scientific Report, March 15–December 14, 1966. (Texas Instruments Inc., Dallas). Dec. 31, 1966. Contract NAS12-75. 242p. (NASA-CR–80010). CFSTI.

A study of the basic design techniques employed to define and develop a telemetry transmitter is presented. Separate sections of the report present an analysis of the system requirements and the selection of the basic transmitter configuration, the detailed design of the individual blocks in the transmitter, the laboratory work, and the effects of radiation on microelectronics. The appendix includes a survey of computer programs available to the design engineer and the computer programs used in the design of the gated discriminator AFC–FM transmitter. (auth) (STAR)

205 (N-67-18431) DESIGN CONSIDERATIONS IN RADIATION HARDENING OF TELEMETRY AND CONTROL CIRCUITRY IN SPACECRAFT. Van Allen, R. L. (National Aeronautics and Space Administration, Greenbelt, Md. Goddard Space Flight Center). [1965]. 15p. (NASA-TM-X-57092). CFSTI.

The failure of the telemetry encoder and electronic data system of Explorer XV due to radiation effects is discussed. A radiation hardening study was conducted to determine if the life of spacecraft electronics could be extended to that of p-n solar cells, and to determine the failure mode of Explorer XV. Only a few subsystems were found deficient and component changes were made in the telemetry encoder and several subcommutating networks. No clues to Explorer XV's transmission failure were found. The component changes were incorporated into Explorer XXVI. The spacecraft was launched and is still operational. Spacecraft electronics systems are now being designed with full consideration of the radiation environment to be expected in the spacecraft's proposed orbit. Examples of close tolerance design are given. The use of Mosfets to reduce circuit parts count and power is discussed along with their radiation vulnerability. However, due to the savings in parts and power, extra shielding weight can be included in the spacecraft to protect the Mosfets. The results of tests to determine the radiation damage properties of Mosfets are given. (STAR)

206 (NAA-SR-12520) LIQUID METAL ENGINEERING CENTER (LMEC). Quarterly Technical Progress Report, April-June 1967. (Atomics International, Canoga Park, Calif. Liquid Metal Engineering Center). Aug. 15, 1967. Contract AT(04-3)-700. 98p. Dep. CFSTI.

Progress is reported on preparation of engineering standards and specifications and practices for liquid metal systems and components. Design studies for the LMEC data acquisition and processing center are reported along with operation of the Sodium Component Test Installation including repairing the sodium heater. Operation of the Liquid Metals Information Center and the Sodium Pump Test Facility is described. The Sodium Pump Bearing and Seal Test Program in which the test rig design was completed and component design is nearing completion is discussed. Sliding friction and wear tests were made in liquid sodium for a number of materials. Operation of gears and bellows in sodium was investigated. Design of the B and W steam generator progressed. Methods for high temperature strain measurements were developed. Information is also included on laboratory support and maintenance of temporarily idle equipment. (F.S.)

207 (NVO-193-3) DESIGN CONSIDERATIONS FOR DEEP HOLE CASINGS. Russell, J. E.; DeHart, R. C. (Southwest Research Inst., San Antonio, Tex.). July 1967. Contract AT(26-1)-193. 42p. Dep. CFSTI.

Several aspects of the design of ring-stiffened cylindrical shells used for casing deep holes are discussed. Loading conditions and failure modes are considered along with factors of safety and materials. Equations for stress and stability analysis are given. Experimental results for stresses in the left ring area are presented and compared with those predicted. Listings of the computer programs used in the analysis are given. Recommendations for further studies that would improve the efficiency of the casing are made. (auth)

208 (ORNL-NDIC-1) SURVEY OF THE USE OF COMPUTER PROGRAMS FOR THE DESIGN AND DESALINATION EVAPORATORS AND THEIR COUPLING TO ENERGY SOURCES. Johnsson, K. O. (Oak Ridge National Lab., Tenn.). Oct. 1967. Contract W-7405-eng-26. 48p. Dep. CFSTI.

A survey of 130 groups believed to be interested in the use of computers for desalination evaporator design and their coupling to the energy source brought replies from 77 groups. Of these, 22 groups were actively using computer programs for desalination studies in September 1966. Names and addresses are given for 50 groups interested in the use of computerized design for desalination. Eleven computer programs are described in abstracts or outlines. The complete programs are probably available to other groups but requests for copies must be made directly to the originators of the programs. (auth)

209 (SC-CR-67-2759) THE MECHANISM CAUSING HEAT DRIVEN PRESSURE OSCILLATIONS IN A GAS-THERMOACOUSTIC GENERATOR DESIGN. Final Report. Feldman, K. T. Jr. (New Mexico Univ., Albuquerque. Bureau of Engineering Research). Sept. 1967. Contracts AT(29-1)-789; 73-2647. 30p. Dep. CFSTI.

For Sandia Corp., Albuquerque, N. Mex.

The operating principles and governing equations for the thermoacoustic phenomenon are reviewed, and an example of the design of a typical thermoacoustic generator is presented. Various geometries of the Sondhauss generator are reviewed as a possible plasma driver for an alternating-current magnetohydrodynamic generator. (F.S.)

210 (TID-24016) STUDY OF IRRADIATED-PASTEURIZED FISHERY PRODUCTS AND OPERATIONAL GUIDE FOR MPDI. Period Covered: October 1, 1965-September 30, 1966. Ronsivalli, L. J.; Carver, J. H.; Kaylor, J. D.; Huff, J. B.; Murphy, E. J. (Bureau of Commercial Fisheries, Gloucester, Mass. Technological Lab.). Oct. 1967. Contract AT(49-11)-1889. 45p. Dep. CFSTI.

Radiopasteurization of seafoods is described. Research conducted from 1960 to 1965 determined the optimum radiation doses and acceptability of air- and vacuum-packed haddock, pollock, ocean perch, and cod fillets and clam meats. Results of preliminary work showed that lobster and mackerel fillets were also amenable to radiopasteurization. In studies of preirradiation quality effects on postirradiation shelf life, the radiopasteurization process was found to be practical for haddock and cod fillets iced for as long as seven to ten days prior to irradiation. Another study showed that many of the available flexible plastic materials having low gas permeability are suitable for packaging radiopasteurized fish. Using gas chromatographic and classical wet chemistry methods, evidence was obtained to show that radiation enhanced the initial development of volatile carbonyls though their concentration never exceeded that which developed in ice-stored nonirradiated products. Radiation was found to suppress the development of volatile sulfide compounds which are known to be spoilage indicators. This might be explained by the fact that data obtained thus far indicate that irradiation at 250 kilorads causes a reduction of about 99 percent in the bacterial numbers, and the source of sulfides appears to be bacterial proteolysis. Nonetheless, taste panel data indicate that irradiated fish eventually spoil and become as objectionable as spoiled nonirradiated fish. (auth)

211 (TID-24088) CALCULATION OF POLES AND ZEROS OF ACTIVE ELECTRICAL NETWORKS USING DIGITAL COMPUTER TECHNIQUES. Scientific Report No. 24. Dunn, D. R.; Pierce, J. F. (Tennessee Univ., Knoxville. Dept. of Electrical Engineering). Dec. 28, 1966. Contract W-7405-eng-26; Subcontract 2160. 27p. Dep. CFSTI.

For Oak Ridge National Lab., Tenn.

Two approaches are described for calculating the poles and zeros of active electrical networks by using a digital computer. The poles and zeros are derived from a set of equations which may include either Bashkow's A-matrix or the network's immittance matrix. For a particular network function, the two approaches are similar and both reduce to a standard form requiring the solution of two characteristic equations. The characteristic equations are in a form suitable for digital computer programming. A single-stage transistor amplifier is used as an example to illustrate both methods. (auth)

212 (UCID-15221) TOPICS IN MAGNET COIL DESIGN. Burgess, T. J. (California Univ., Livermore. Lawrence Radiation Lab.). June 3, 1965. Contract W-7405-eng-48. 18p. Dep. CFSTI.

Magnet coil design calculations are summarized. The calculations were performed to solve two kinds of problems: synthesis and analysis. Synthesis problems entail the design of a coil to fulfill specified requirements, such as to create a field of given magnitude and homogeneity within a given temperature rise. Analytical techniques are used to predict magnet coil performance from relevant parameters of the design and excitation. (F.S.)

213 (UCRL-70590) BEAM LINE LIQUID HELIUM CRYOPUMP. Denhoy, Balwant S. (California Univ., Livermore. Lawrence Radiation Lab.). Sept. 16, 1967. Contract W-7405-eng-48. 19p. (CONF-671017-1). Dep. CFSTI.

From 14th Annual Symposium of the American Vacuum Society, Kansas City, Mo.

A beam line liquid helium cryopump has been designed and built for Alice (a neutral-injection, controlled thermonuclear research machine). This pump prevents large quantities of hydrogen and other residual gases from entering into the ultrahigh vacuum environment chamber for plasma. The beam line cryopump consists of an annular tube through which the neutral energetic beam passes. The annular volume is connected to a helium reservoir above it by two well-insulated and shielded lines. Thermal syphoning effect causes the circulation of liquid helium from the annular pumping surface to the liquid helium reservoir and eliminates the presence of gas pockets and hot spots on the pumping surface. This pump has a 4800-cm^2 bare metal cryogenic pumping surface that can be subcooled to the Lambda point or lower. The pumping speed for hydrogen was measured at 2°K to be 100,000 liters/sec at a system pressure of 8×10^{-10} torr. The heat leak was measured to be 0.75 watt. (auth)

214 (ANL-Trans-520) DESULFURIZATION OF FLUE GASES: IMPORTANCE AND PRACTICAL POSSIBILITIES. Johswich, F. Translated by Elmar K. Wilip (Argonne National Lab., Ill.), from Brennst.-Waerme-Kraft, 14: 105-15(1962). 30p. Dep. CFSTI. JCL $3.60 fs, $1.13 mf.

Chimneys together with the desulfurization of fuel which cannot be applied to all kinds of fuel do not suffice in order to prevent the increasing contamination of the atmosphere by toxic sulfur compounds. Purification procedures for flue gases become therefore mandatory. A critical consideration of the basic proposals shows that additives and wet washing procedures are not applicable. Among the dry absorption and adsorption procedures the latter possess greater chances of success with respect to technical application and economic feasibility. Among the available absorbents at the present time only active carbon is suitable, despite its high price. The development of a new procedure puts the use of active carbon on a more tolerable price level and permits therefore a much wider application of the flue gas purification. The attached cost calculations have been applied for reasons of simplicity only to fuel oil. They can be applied after a corresponding recalculation also to mineral coal or other fuels. (auth)

215 (LA-tr-67-81) EFFICIENCY OF FILTERS FOR RADIOACTIVE AEROSOLS. Kimura, K. Translated from Rodo Kagaku, 42: 696-702(1966). 13p. Dep. CFSTI. JCL $1.60 fs, $0.80 mf.

Examinations of various kinds of dust filters were carried out using a radioactive solid aerosol of thoron daughter elements from thorium nitrate. Electron micrographs of the thoron disintegration products collected by a thermal precipitator and an investigation of the relation between the filtering efficiency and number of sheets of filter paper showed that the diameter of the aerosol particles was very small and fairly uniform. Thoron and thoron disintegration products generated from thorium nitrate in a flask were led through a polyethylene tank to the dust filter to be tested and several kinds of dust filters were tested for their filtering efficiency by measuring the radioactivity of the aerosol before and after filtration. The radioactivity measurements were made by means of a membrane filter. The filtering efficiency was generally low in most kinds of dust filters that usually showed high filtering efficiency for ordinary dust particles. This fact seemed to be due to the small particle size of radioactive aerosol. A glass fiber filter used in the measurement of dust concentrations and an ACG (asbestos, cellulose, glass fiber) filter had a filtering efficiency of over 99% even for the radioactive aerosol. (auth)

216 PROPERTIES OF ANTENNAS FOCUSED IN THE FRESNEL ZONE. Musil, J. (Inst. of Plasma Physics, Prague). Czech. J. Phys., 17: 874-88(1967).

The paper deals with the calculation of the electric field strength distribution of a circular antenna focused in the Fresnel zone. To express the electric field strength distribution, $^{n}w_{p-1}(w,x)$ functions defined by Lommel functions of two variables are used. On the basis of the calculated electric field strength distribution, the fundamental properties of an antenna focused in the Fresnel zone are determined. The width and depth of the focused beam are calculated and the results of the numerical computations are plotted. Formulas for determining the wavelength in the focused beam are expressed as a function of the circular aperture illumination. (auth)

217 SPECIAL FABRICATION TECHNIQUES. Reactor Mater., 10: 194-202(Fall 1967).

The melting and fabrication of cast materials for reactors are discussed. The fabrication of powdered materials is summarized. Pressure bonding, nonelectric chemical bonding, electroplating, brazing, welding, and ultrasonic techniques are discussed for fabrication techniques used in reactor materials. A listing of 43 references is given. (J.C.W.)

218 MAGNETOHYDRODYNAMIC THRUST BEARING. Maki, E. Roland (General Motors Corp., Warren, Mich.); Kuzma, Dennis C.; Donnelly, Russell J. J. Fluid Mech., 30: 83-95(Oct. 17, 1967).

The magnetohydrodynamic lubrication flow in a step-type thrust bearing was investigated both theoretically and experimentally. The experimental configuration consisted of nine identical segments arranged on a circular plate. Flow was induced by rotating the upper plate. Pressures, voltages and torques were recorded. Provision was made for passing current radially through the segments, and it was shown that the torque could be reduced to zero, and even reversed, by this means. Good agreement was obtained between the analysis and the experimental results. (auth)

219 PREMISES FOR THE NEW 2000 CURIE ^{137}Cs RADIATION UNIT. Nolet, G.; Gillet, J.; Bascq, Z. M. (Univ., Liege). Acta Radiol., Ther., Phys., Biol., 6: 219-24(June 1967).

The installation of a 2000 curie cesium-137 irradiation unit at the Laboratories de Radiobiologie is described. The versatile premises are designed for promotion of scientific research in the fields of radiobiology and chemistry and were in use since May 1965. The facility is in concrete and of cylindrical shape with a diameter of 7 m and height of 2 m. The targets can be placed at a distance of 30 cm to 3.5 m from the source. The shielding container, which also was used as a shipping container, is made of iron-coated lead with a minimum thickness of 17 cm. The contact dose rate is 0.3 mR/h. Any dose rate between 180 kR/h and 60 R/h can be obtained. No difficulties were encountered in the use of this ^{137}Cs facility. (auth) (SWED)

220 CREEP BUCKLING OF COLUMNS WITH LATERAL RESTRAINT. Freed, N. H. (Atomic Energy Board, Pelindaba, S. Africa); Alexander, J. M. J. Strain Anal., 2: 137-51(Apr. 1967).

Creep buckling of columns with lateral restraint arises from the use of vertical fuel elements in graphite-moderated types of nuclear reactors. Previous theoretical work based on the tangent rate modulus approach was extended to cover all phases of creep and elastic deformation for both symmetric and asymmetric single-plane bowing. By introducing a solution-time parameter, a generalized solution can be derived for any given material and initial shape, which is valid for an arbitrary range of sizes of rod, temperatures, and loads (neglecting elasticity). For Magnox at 295°C the theory indicates that elastic deformation is negligible. It was found that experiments on round Magnox rods which were allowed to lie against a simulated channel wall (this is the condition described as continuous lateral restraint) that creep bowing seldom occurred in a single plane. Comparison with the theoretical analysis for such cases was therefore difficult, but it was found that the theoretical predictions were generally very conservative, and that by splitting the measured deflections into major and minor planes some correlation could be obtained. By using a specimen of rectangular cross-section having an aspect ratio of 2:1, bowing was confined to a single plane and very good agreement with the theory was obtained, both with respect to the deflected shape itself and to the time required to achieve it. (auth) (UK)

221 A GLOVE-BOX AND DRYING SYSTEM FOR THE MANIPULATION OF MOISTURE SENSITIVE MATERIALS. Dryburgh, P. M. (Univ. of Glasgow). J. Sci. Instrum., 44: 658-60(Aug. 1967).

A system is described for the provision of a working atmosphere in a commercially available glove-box. Air is pumped out of the box, chilled, passed through a column of cooled molecular sieve, and returned to the box. The air-lock of the box can be treated separately, allowing the removal and introduction of equipment while maintaining dry conditions in the main compartment. Pressure in the box is controlled by foot switches operating electromagnetic valves. A device for the measurement of frost-point is described, by means of which it has been shown that the frost-point of the air in the box is less than −90°C, corresponding to a moisture content of 10^{-4}mg l^{-1} (approximately 0.1 p.p.m.). Transfer of items from the laboratory to the working chamber is simple and rapid, the air lock requiring about 15 minutes for operation. (auth) (UK)

222 A LOW-BACKGROUND SAMPLE CHANGER. Koeppe, P. (Freie Univ., Berlin). Atompraxis, 13: 354-7(Aug. 1967). (In German).

A sample changer is described which can be constructed with little additional equipment. If the available equipment of a whole-body counter is used, the device can deliver automatic evaluation of up to 500 samples with an extremely low background and almost maximum efficiency (ca 60%). (auth)

223 PARTICLE SIZE ANALYSIS. Proceedings of a Conference held at Loughborough University of Technology, Loughborough, Eng., September 14-16, 1966. London, Society for Analytical Chemistry, 1967. [365p.]. 147s. (CONF-660954). DTIE.

A total of 27 papers were presented at the conference. Separate abstracts were prepared for three papers. Papers for which no abstracts were prepared are concerned with methods for powder handling, manual counting, automatic counting, sedimentation, and surface areas. (J.R.D.)

For abstracts of individual papers see: 224, 737, and 1781.

224 PARTICLE SIZE BY β BACKSCATTERING. Hardwick, W. H.; Laundy, B. J. (Atomic Energy Research Establishment, Harwell, Eng.). pp 206-11 of Particle Size Analysis. London, Society for Analytical Chemistry, 1967.

From Conference on Particle Size Analysis, Loughborough, Eng., Sept. 14-16, 1966. See CONF-660954.

The technique of measuring the cumulative deposition of ma-

terial on the bottom of a sedimentation column by recording the intensity of β-radiation scattered from the base of the column is described. The technique can be used to measure the particle size distribution of a single sample in both the gravitational and centrifugal regions, covering the range 0.1 to 80 μ. Recent improvements to the original technique are described, which enable a wide range of powders having an effective atomic number lower than the original limit of 16 to be analyzed, bringing such materials as graphite and magnesia into the range of application. (auth)

225 IMPROVEMENTS IN OR RELATING TO IRRADIATION APPARATUS. Rogers, Frank (to United Kingdom Atomic Energy Authority). British Patent 1,088,518. Oct. 25, 1967. Filed Apr. 26, 1965.

An apparatus is described for the irradiation of cylindrical articles with a source of γ radiation. The apparatus consists of a vertical hollow member which surrounds the γ source, a guide structure consisting of a curved rail track supported on a framework. The vertical member and the guide structure define a helical passageway for the cylindrical articles to be irradiated. A method is provided for rotating the vertical member in relation to the guide structure and rolling the article to be irradiated around the vertical member. (F.S.)

226 IMPROVEMENTS IN HEAT EXCHANGERS. Lawrence, Arthur Charles (to Foster Wheeler Ltd.). British Patent 1,088,956. Oct. 25, 1967. Filed July 10, 1963.

A method is described for joining a tube which passes through a wall of a shell to the shell. The tube has an integral surrounding skirt which plugs a correspondingly shaped hole in the shell wall. The skirt is welded to the shell wall and forms part of the wall. This method is used with a heat exchanger consisting of a cylindrical shell containing a bank of tubes connected at their ends to cylindrical headers whose outlet or inlet passes out through the shell wall. This is useful in a steam generator which derives power from an organic moderated and cooled nuclear power plant. (F.S.)

227 CELL STRUCTURE FOR HEAT EXCHANGER. Maillet, E. (to Commissariat a l'Energie Atomique). Canadian Patent 756,714. Apr. 11, 1967. Priority date Feb. 8, 1962, France.

A tubular element cell promotes heat transfer by maintaining a liquid film on its inner wall in contact with an axial flow of vapor of the same liquid. An external liner is divided into two portions of equal length by an intermediate partition extending at right angles to the cell axis. An inlet duct for a cooling liquid and several nozzles for vaporizing the liquid are disposed symmetrically at intervals about the axis of the cell. The nozzles are designed to throttle the liquid phase and to form a liquid film on the inner wall of the vaporization elements. The film flows in an axial direction with a helical motion along the element walls. The device claims to avoid burnout. (F.S.A.)

228 DEVICE FOR DIRECTIONAL CONTROL OF MOVING RADIATION SOURCE. Kypta, J.; Dostal, P. (to Chirana Praha, narodni podnik). Canadian Patent 760,525. June 6, 1967.

In medical radiation treatment it is essential that the affected part should receive a uniform dose with minimum exposure to surrounding tissues. Instead of a rotating radiation source this device uses a timing device so that all radiation is received while the source moves through a pre-determined angle of 60 to 240°. (F.S.A.)

Heat Transfer and Fluid Flow

Refer also to abstracts 200, 227, and 1908.

229 (AAEC/E-178) VELOCITY DISTRIBUTION AND PRESSURE LOSSES FOR RANDOMLY PACKED BEDS OF SPHERES. Price, J. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). June 1967. 25p. Dep.

Measurements were made of fluid velocity distributions for a number of randomly packed beds of spheres using a flow separator between the exit face of the bed and the plane of measurement. The results for right cylindrical beds show that the departures from uniformity were small, except for a region within one half sphere diameter from the walls of the containing vessel where a marked increase in velocity occurred. The distribution was found to be independent of Reynolds number ($1470 < N_R < 4350$) and bed length ($9 < L/d < 36$). It was only slightly affected by the method of loading the bed, the density and tolerance of the spheres, and sphere diameter ($12 < D/d < 48$). A marked change was found for a bed which was peaked at exit. Measurements of the pressure losses across the beds were also made. The resulting friction factors for the right cylindrical beds were correlated using the general pressure loss correlation in its normal form and also in a modified form which took the measured velocity distributions into consideration. Both catered adequately for different packing methods and sphere diameter, but not for different bed lengths. Results are presented for the additional pressure losses caused by a peak at exit. (auth)

230 (AAEC/TM-389) RADIAL HEAT TRANSFER AT THE WALL IN PACKED BEDS. Chan, B. K. C.; Lawther, K. R. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). May 1967. 29p. Dep.

A literature survey indicates that adequate mathematical models are available for the study of heat transfer in packed beds. However, experimental data have been obtained at low Reynolds numbers only, below 3500. Experimental results are reported for a 7 in. diameter bed packed with 0.489 in. and 0.658 in. diameter glass spheres, with preheated air as the fluid flowing in the bed. Results indicate that the bed-to-wall heat transfer coefficient h_w, based on the wall temperature and a bulk gas temperature, may be best correlated by the relation $Nu = 2.35\ Re^{0.63}$ to a standard deviation of 11.4 per cent for values between 2,000 and 15,000. 62 references are given. (auth)

231 (AEEW-R-542) APPLICATION OF A FILM FLOW MODEL TO PREDICTING BURN-OUT UNDER TRANSIENT CONDITIONS. Leslie, D. C.; Kirby, G. J. (Atomic Energy Establishment, Winfrith (England)). Aug. 1967. 28p. Dep. CFSTI. UK 5s. 0d.

The film flow model developed previously has been generalized to transient situations by assuming that only convection is changed by the transient; evaporation, deposition and entrainment are assumed to be unaffected. A computer code TRABUT computes the time behavior of the mass velocity and the quality by the method of characteristics, and then integrates the film flow equations along the same characteristics until the point of burn-out or zero film flow is reached. The time delay between the onset of a transient and burnout has been computed both for flux and flow transients. These computations have been compared with those made using the standard local conditions hypothesis. The film flow model gives shorter delays in almost all cases, but the difference would not be detectable with present experimental techniques. (auth)

232 (BM-RI-7035) STUDY OF HEAT TRANSFER TO WATER-COOLED COPPER CRUCIBLES DURING VACUUM ARC MELTING. Clites, P. G.; Beall, R. A. (Bureau of Mines, Albany, Oreg. Albany Metallurgy Research Center). [1967]. 36p. Dep. CFSTI.

The patterns of heat transfer to water-cooled copper crucibles during vacuum arc melting are determined. Values of heat flux from the ingot to the crucible were determined during nonconsumable electrode vacuum arc melting of zirconium and during consumable electrode vacuum arc melting of titanium, zirconium, and steel. The results of these studies confirm the existence of a high thermal resistance between the ingot and the crucible wall which results from the shrinkage of the ingot as the metal solidifies. Maximum heat flux occurs near the top of the ingot where maximum values of heat flux of 1.4×10^6 Btu/ft^2 hr were observed during small-scale consumable electrode arc melting of zirconium and titanium. The maximum heat flux for consumable electrode arc melting of 8-inch-diameter ingots was 0.5×10^6 Btu/ft^2 hr. The effects of electrode material, electrode diameter, arc current, and arc potential on heat flux from the ingot to the crucible were studied. Data were also obtained on crucible wall temperatures and on the effect of very narrow annular water jackets. (auth)

233 (NP-17095) DETERMINATION OF THE TUBE-WALL TEMPERATURE IN A HEAT EXCHANGER FROM THE TUBE RESISTANCE. Watson, G. G.; Clark, R. D. (National Engineering Lab., Glasgow (Scotland)). Jan. 1967. 39p. (NEL-272). Dep.

The use of a tube as its own resistance thermometer has been investigated in a simple steam condenser with a single tube of aluminium-brass or titanium. A precision ac bridge incorporating an inductive voltage divider was developed for measuring the very low resistance of the tube. The stability of the tube resistance was also studied. The sensitivity for a 16.5 cm ($6\frac{1}{2}$ in.) section of the tube length was 0.05°C and the accuracy $\pm\frac{1}{4}$°C after calibration. Annealing of the tube is necessary, and corrosion or erosion can cause a gradual change in calibration. The average temperature of the tube section was measured. The surface temperature may be derived assuming that the heat flux is known. Derived surface temperatures for some heat transfer measurements are compared with values predicted from the condenser performance. Resistance measurements were also made with a potentiometer in a dc circuit. Calibration and applications are discussed. (auth)

234 (ORNL-TM-1975) PROCEEDINGS OF SECOND SOUTHEASTERN SEMINAR ON THERMAL SCIENCES, JULY 25-26, 1966, OAK RIDGE, TENNESSEE. Hoffman, H. W.; Vachon, R. I. (eds.) (Oak Ridge National Lab., Tenn.). Oct. 1967. Contract W-7405-eng-26. 195p. (CONF-660723). Dep. CFSTI.

Lectures are included on prediction of natural convection and radiation, fictive film concept, research on boiling and condensing, and atmospheric turbulence and diffusion. Progress reports are included on radiation gas dynamics; free convection heat transfer to air between narrow channels; stabilization of rotating flows with intense magnetic fields; turbulent transport in wall jet flow; pressure losses in tubing and fittings; arc heated wind tunnel investigation of the effect of heat-transfer rate, low density, and orifice size on static pressures; reflectance in film-covered water surfaces; solution of nonlinear equations; pool boiling on stainless steel; film and transpiration coding of hypersonic nozzle throats; similarity techniques in space vehicle testing; and transient thermal stresses in a cylinder with an internal heat source. (F.S.)

235 (SC-RR-66-576) EMITTANCE VALUES OF HAYNES-25 FOR A SELECTED REENTRY ENVIRONMENT. Deveney, J. E. (Sandia Corp., Albuquerque, N. Mex.). Aug. 1967. 41p. Dep. CFSTI.

Measurements of total normal and total hemispherical emissivities were performed on specimens of Haynes-25 having various thicknesses of oxide. This program was undertaken to develop emissivity values for use in Aerospace Nuclear Safety reentry analyses where the oxide is developing during reentry. (auth)

236 (ORNL-tr-1802) SIMPLIFIED REPRODUCTION OF THE CONTROLLER ACTION OF A STEAM SUPERHEATER ON THE ANALOG COMPUTER. Hanus, B. Translated by R. Gregg Mansfield (Oak Ridge National Lab., Tenn.), from Reglungstechnik, 13: 14-20(1965). 12p. Dep. CFSTI. JCL $1.60 fs, $0.80 mf.

A simplified method of simulating on an analogue computer the control behavior of a steam superheater is described, and has already proved in many cases to be very useful for calculating the control quality of a steam-temperature control loop. A simplified differential equation, describing the system, forms the basis for the model. The step function response derived from this equation differs from the response of the actual system with respect to dynamic behavior, but regarding static behavior, it represents exactly the actual system. Also identical to the actual system are the initial jumps in the step function response, which appear following a change in the steam entry temperature or the flow rate of steam. The application of the approximation formula enables the response behavior of a steam superheater to be simulated simultaneously for all four input variables and that with the smallest possible number of integrators. The total number of integrators depends on the order of approximation function. The various disturbances are fed independently into the model. (auth)

237 ADVANCES IN HEAT TRANSFER. VOLUME 4. Hartnett, James P.; Irvine, Thomas F. Jr. Advan. Heat Transfer, 4: 1-458(1967).

Recent advances in heat transfer, prompted by developments in the fields of atomic energy, aerodynamics, and astronautics, are reviewed. Heat transfer analyses for free convection on a vertical surface with both laminar and turbulent flow are presented. General information on heat transfer between the human organism and its various environments, including natural and artificial environments on earth, underwater, and in space, is given as well as particular information concerning the role of skin in heat transfer. Information on the effects of low gravity on heat transfer is reviewed and summarized, and experimental and theoretical results in this field are compared and interpreted. Included in the heat transfer processes studied are free convection, pool boiling, forced convection boiling, condensation, and combustion. Knowledge of plasma heat transfer processes is surveyed and encompasses basic thermodynamic studies of plasma and the effects of applied electric and magnetic fields on plasma heat transfer. Finally, comprehensive, systematic, and accurate tables of solutions to the laminar boundary-layer similarity equations for a perfect homogeneous gas are presented along with explanation of their applications and numerical solutions. (L.C.L.)

238 EXPERIMENTAL INVESTIGATION OF THE TRANSIENT RESPONSE OF THE VOLUMETRIC CONCENTRATION IN A BOILING FORCED-FLOW SYSTEM. Staub, F. W.; Zuber, N.; Bijwaard, G. (General Electric Co., Schenectady, N. Y.). Nucl. Sci. Eng., 30: 279-95(1967).

Data are presented on the transient response of the vapor volumetric concentration in a boiling liquid. The experiments were conducted with Refrigerant-22 in forced upward flow through an electrically heated circular tube. Experiments were performed by oscillating the power input to the metal test section while maintaining a constant discharge pressure and a constant inlet liquid velocity. The amplitude of the power oscillations was varied between 5 and 40% of the average power at frequencies between 0.01 and 10 cps. Steady-state and transient void fractions were measured at six axial locations using a two-beam x-ray attenuation traverse method. Satisfactory agreement is shown between the results predicted by the void propagation equation and the experimental data. It is shown that: the rate of propagation of the voids as well as the wave form of the void disturbance as it propagates along the duct can be predicted by means of kinematic waves; the void response depends upon the flow regime; and both the propagation velocity and the wave form can be predicted rather accurately if the effects of flow regime are taken into account. The loss of accuracy, introduced by not considering the effect of flow regime, is also demonstrated. (auth)

239 EBOLI: A RESEARCH PROGRAM ON BOILING. Pinchera, Giovanni Carlo. Com. Naz. Energ. Nucl., Notiz., 13: No. 7, 55-69(July 1967). (In Italian).

Results of a two-year study on boiling in free convection are summarized. The experimental apparatus used is described and sketched. In studies on the fundamental aspects of boiling the mechanisms of nucleate boiling are given. The growth of the bubble and the effect of the form factor on the growth are discussed. Statistical data are given on the bubble parameters. The thermal exchange obtainable by boiling was evaluated for various liquids and the results are shown graphically. The critical thermal flux was evaluated for seven liquids. (37 references.) (J.S.R.)

240 AN INVESTIGATION OF DEPARTURE FROM NUCLEATE BOILING (DNB) IN A CROSSED-ROD MATRIX WITH NORMAL FLOW OF FREON-113 COOLANT. Coffield, Ronald D. Jr.; Rohrer, W. M. Jr.; Tong, L. S. (Univ. of Pittsburgh). Nucl. Eng. Design, 6: 147-54(1967).

While the boundary layer behavior dictates the heat transfer of a single-phase flow, the bubble layer dominates the boiling heat transfer of a low void fraction two-phase flow. The bubble layer is a highly viscous layer of crowded bubbles flowing parallel to the heating surface. In a subcooled or low quality boiling flow, the bubble layer locates between the main liquid stream and the heated wall. It shields the wall from the incoming cooling liquid so that the wall can be overheated and reach the heat flux density causing Departure from Nucleate Boiling (DNB). Increase in the DNB heat flux of the rod bundle in a PWR core can be achieved by breaking the bubble layer. One way to break the bubble layer is to introduce the coolant flow normal to the fuel rods. Normal flow may induce vibration of the rod banks. However, flow-induced vibration is absent in a crossed-rod matrix when two adjacent banks of rods are in contact at a 90 degree angle. However, this may cause concern to the reactor designer, because the rod-contact point produces a hot spot which might cause a premature DNB. The DNB heat fluxes measured in freon flow normal to a crossed-rod matrix having all rods heated are reported. The result is that the DNB heat flux at the rod-contact point is much higher than that in flow parallel to the rod bundles. (auth)

241 AN ANALYTICAL INVESTIGATION OF THE TRANSIENT RESPONSE OF THE VOLUMETRIC CONCENTRATION IN A BOILING FORCED-FLOW SYSTEM. Zuber, Novak; Staub, F. W. (General Electric Co., Schenectady, N. Y.). Nucl. Sci. Eng., 30: 268-78(1967).

The transient behavior of the vapor volumetric concentration in a two-phase flow system with a change of phase is formulated in terms of kinematic waves, and expressed as a propagation equation. The derived void propagation equation predicts the void response to variations of power density, liquid inlet velocity, system pressure, thermodynamic nonequilibrium in the liquid and/or in the vapor, compressibilities of the liquid and of the vapor, flow regime, and body forces. For a boiling forced-flow system, the results of the analysis show that: the rate of propagation of the voids, as well as the change, i.e., the distortion of the void disturbance as it propagates along the duct, can be predicted by means of kinematic waves; the rate of propagation of kinematic waves depends on the volumetric flux density of the mixture, the drift velocity of the vapor, and the vapor volumetric concentration; since the velocity of kinematic waves depends on concentration, the wave forms may develop discontinuities resulting in kinematic shock waves; and the void response depends, definitively, upon the flow regime and it may change, completely, with a change in flow pattern. (auth)

242 VOID RESPONSE TO FLOW AND POWER OSCILLATIONS IN A FORCED-CONVECTION BOILING SYSTEM WITH AXIALLY NONUNIFORM POWER INPUT. Staub, F. W.; Zuber, N. (General Electric Co., Schenectady, N. Y.). Nucl. Sci. Eng., 30: 296-303(1967).

The void propagation equation is applied to predict the void response to both flow and power oscillations in a boiling liquid in forced flow through a duct with axially nonuniform power input. The analysis and the solution are presented in dimensionless form so they may be applied to various systems of practical interest. For the range of parameters examined in this paper, neither the steady-state void fraction nor the transient void response are significantly affected by the shape of the axial power-input distribution to the fluid. The predicted void response to combined flow and power-input oscillations to the fluid indicates that: the void propagation velocity is about the same whether the power alone, flow alone, or power and flow together are oscillated, provided all other parameters are unchanged; flow oscillations in phase with power oscillations reduce the amplitude of the void oscillations below the values that would be present with either the same power or flow oscillations acting alone; and flow oscillations 180° out of phase with power oscillations result in void oscillations whose amplitudes are roughly equal to the sum of the void amplitudes that would exist with the respective power and flow oscillations acting alone. (auth)

243 FLUIDIZATION. Lewis, J. B.; Partridge, B. A. (Atomic Energy Research Establishment, Harwell, Eng.). Nature (London), 216: 124-7(Oct. 14, 1967).

The theory of gas and liquid fluidization is discussed. Improved application of some earlier techniques is beginning to reveal something of the behavior of bubbles and solids during gas fluidization. (auth)

244 FORCED AND PERIODIC VORTEX BREAKDOWN. Sarpkaya, Turgut (Naval Postgraduate School, Monterey, Calif.). J. Basic Eng., 89: 609-16(Sept. 1967).

The results of an experimental study of the forced and periodic breakdown of a confined vortex rotating in the opposite direction are presented. The vortex tube consists of two chambers connected by a short conduit through streamlined transitions. The upstream end is closed by a plain wall, and a circular orifice is provided at the downstream end. The swirling flow and the breaker-vortex are generated by introducing varying proportions of air or water through tangential ports located near the upstream and downstream walls of the unit. The cases of single breakdown and periodic breakdown are explored and typical data are presented for each case. Finally, the pros and cons of the two existing transition theories are discussed. (auth)

Isotope Technology

Refer also to abstracts 119, 311, and 1029.

245 (BNL-11435) RADIOISOTOPE GENERATORS FOR CLINICAL USE. Richards, Powell (Brookhaven National Lab., Upton, N. Y.). June 1, 1967. 15p. (CONF-670617-1). Dep. CFSTI.

From Annual Meeting of the Section on Radiology of the American Medical Association, Atlantic City, N. J.

Refinements in the design of the ^{99m}Tc generator are discussed. These include: simplified milking procedure, reduced radiation exposures, and improved quality of product solution. The problems involved in the routine use of nuclides eluted from a generator are considered. Five radioisotope generators were developed to the point where they are routinely available commercially: ^{132}I, ^{99m}Tc, ^{87m}Sr, ^{68}Ga, and ^{113m}In. Clinical applications are listed for the ionic forms of the nuclides. (M.C.G.)

246 (N-67-18580) REPORT ON THE DEVELOPMENT OF THE MANNED ORBITAL RESEARCH LABORATORY (MORL) SYSTEM UTILIZATION POTENTIAL. TASK AREA IV. MORL SYSTEM IMPROVEMENT STUDY. Pisciotta, A. (Douglas Aircraft Co., Inc., Santa Monica, Calif. Missile and Space Systems Div.). Jan. 1966. Contract NAS1-3612. 396p. (NASA-CR-66293; SM-48819B). CFSTI.

Integration of the updated bipropellant and advanced thrustor systems with the Manned Orbital Research Laboratory (MORL) is detailed to provide a basis for a comparison of the complete integrated MORL propulsion/reaction control systems. Flight mechanics stabilization and control are considered, as are environmental control and biological waste from the crew. Interfaces between the thrustors and the baseline MORL configuration and structure are discussed in detail. Other aspects of systems integration considered are logistics resupply, the power system, and crew and missions operations. Development plans are included for updated bipropellant, resistojet, and radioisotope thrustor systems. Functional requirements, preliminary design specifications, and operational details are defined for the propulsion/reaction control system that will be used to provide control impulses to the space laboratory. An exhaust plume analysis, a reliability analysis, radioisotope thrustor shielding curves, and pressure spikes associated with vacuum ignition are described. (STAR)

247 (N-67-18969) SNAP-8 MATERIALS REPORT FOR JULY-DECEMBER 1965. Derow, H.; Farwell, B. E. (Aerojet-General Corp., Azusa, Calif.). Feb. 1966. Contract NAS5-417. 99p. (NASA-CR-72146). CFSTI.

A materials testing guide for the selection of materials for the components of the SNAP-8 system, whose ultimate objective is the design and development of a 35-kw electrical generating system for use in various space missions, is presented. Work in the following areas is reported: test operations support, fabrication support, Satellite 6B evaluation, alternate turbine materials evaluation, evaluation of the -1 boiler, and corrosion loop program. (STAR)

248 (NP-17092) A NOTE ON THE PREPARATION OF ^{235}U FISSION SOURCES. Marshall, M.; Scobie, J. (Scottish Research Reactor Centre, East Kilbride (Scotland)). Aug. 1967. 10p. (SRRC-20/67). Dep.

The preparation of ^{235}U fission sources on foil backing materials by painting and by electro-deposition is described. The specific conditions for obtaining uniform adherents of up to 0.5 mg/cm^2 U on 0.005 in. thick Ni backing and 0.010 in. thick Al backing are given. (L.C.L.)

249 (NYO-3491-2) GENERATION AND PRACTICAL USE OF MONOENERGETIC X-RAYS FROM ALPHA EMITTING ISOTOPES. Annual Report. Sellers, Bach; Papadopoulos, John; Wilson, Henry (Parametrics, Inc., Waltham, Mass.). Feb. 1967. Contract AT(30-1)-3491. 64p. Dep. CFSTI.

Studies of the application and generation of monochromatic alpha-excited x-rays were continued. The research reported includes evaluations of various alpha sources, their mountings and environmental aspects of the generation method. The use of various types of proportional counters as detectors is discussed. Applications studied include alloy analysis, lubricating oil contaminant analysis, trace identification, and two-element mixture analysis. Several yield measurements are reported and compared with proton excited x-ray yields. Several potential applications, including analysis of extraterrestrial surfaces, are discussed. (auth)

250 (ORNL-IIC-10(Vol.2)) PROCEEDINGS OF 2ND SYMPOSIUM ON LOW-ENERGY X- AND GAMMA SOURCES AND APPLICATIONS HELD AT UNIVERSITY OF TEXAS, AUSTIN, TEXAS, MARCH 27-29, 1967. Baker, Philip S.; Gerrard, Martha (eds.) (Oak Ridge National Lab., Tenn.). Sept. 1967. 444p. (CONF-670321-(Vol.2)). Dep. CFSTI.

Twenty-one papers and abstract of another paper presented at the conference are given. Separate abstracts were prepared for 20 of the papers. One paper was previously abstracted for NSA. For abstract number of the paper see CONF-670321 in the Report Number Index. (M.C.G.)

For abstracts of individual papers see: 10, 11, 170, 251-262, 309-311, 342, and 384.

251 (ORNL-IIC-10(Vol.2), pp 629-38) POWDER SAMPLE AND SINGLE-CRYSTAL X-RAY DIFFRACTION UTILIZING THE ELECTRON CAPTURE RADIATION OF ^{55}Fe AND THE BETA-STIMULATED K X-RAY DOUBLET. Toothacker, William S.; Preuss, Luther E.; Bugenis, Claudius K. (Edsel B. Ford Inst. for Medical Research, Detroit, Mich.).

Bragg diffraction of x rays using beta-excited x-ray sources and a ^{55}Fe electron-capture source with powder and single-crystal samples were demonstrated and evaluated. A special diffractometer incorporating a relatively intense ^{55}Fe linear source (1.5 mm × 10 mm) was used, in conjunction with a proportional counter, linear pulse amplifiers, and a multichannel analyzer. Manganese K x rays from the ^{55}Fe source were diffracted with detectable intensity by sodium chloride and lithium fluoride powder samples. Intensity was about 10 photons per minute at the detector. The peak was about 2 degrees wide at half-height for the LiF powder 200 peak, the poor resolution being due to open aperturing used for optimizing intensity. A 240-fold intensity increase was observed with a LiF single-crystal sample. With this increased intensity, aperture widths were reduced to improve resolution. The diffraction intensity on the LiF single crystal was 1400 counts per minute and resolution of .29 degree full width at half-height of the Gaussian. The stability, small size, and simplicity of the ^{55}Fe source make it a promising x-ray diffraction source. Detection of the diffracted photons by film rather than proportional counter was demonstrated. Diffraction using a 4-mc ^{147}Pm-Cu beta-excited source was successful. (auth)

252 (ORNL-IIC-10(Vol.2), pp 63947) EVALUATION OF ^{55}Fe X-RAY SOURCES FOR PORTABLE STRESS ANALYSIS

EQUIPMENT. Semmler, R. A. (IIT Research Inst., Chicago, Ill.).

Studies on an ^{55}Fe source indicated that a portable diffraction camera can be developed for use with film, using currently available sources. (auth)

253 (ORNL-IIC-10(Vol.2), pp 648-62) RADIOGRAPHIC CHARACTERISTICS OF ^{169}Yb. Clarke, E. T.; Coenraads, C. N. (Technical Operations, Inc., Burlington, Mass.).

The characteristics of the isotope ytterbium-169, a low-energy gamma emitter which promises to be of utility in the radiographic inspection of thin sections of steel and aluminum are described. Isotopes commonly available for radiography emit energies in the range of 300 to 1200 kilovolts effective energy; only a very few isotopes emitting predominantly low-energy radiation can at the same time be economically produced at practical intensity levels. ^{169}Yb emits predominantly 50 keV radiation with components up to 300 keV, and small focal spot sources can be made in strengths up to several r/hr at 1 meter. (auth)

254 (ORNL-IIC-10(Vol.2), pp 663-95) SOME RECENT DEVELOPMENTS IN LOW-ENERGY X- AND GAMMA-RAY SOURCES AND APPLICATIONS IN AUSTRALIA. Watt, J. S. (Australian Atomic Energy Commission Research Establishment, Lucas Heights).

The use of γ-ray-excited x-ray sources (γX sources) in x-ray-fluorescence analysis is described. Brief comments are made on technique. Analyses for eleven two-component applications are compared with results using bremsstrahlung sources. Methods using γX sources for correction for the matrix effects in complex samples are discussed, and results of experiments to determine zinc in both lead–zinc ore and slag are presented. Low-energy γ-ray absorption techniques for the determination of lead in ore pulps and in mill products are described. One method depends on preferential absorption by lead of low-energy (225 keV) γ-rays, with compensation for density variations. The second method depends on absorption of both ^{153}Gd γ-rays and lead K x-rays from a γX source. The techniques have been proved by experiment. (auth)

255 (ORNL-IIC-10(Vol.2), pp 696-722) PROGRESS IN THE STUDY AND APPLICATIONS OF LOW-ENERGY-PHOTON RADIOACTIVE SOURCES. Martinelli, P.; Robert, A.; Cavailles, J. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires).

X-ray fluorescence has been applied on a laboratory scale to the analysis of both low- and high-atomic-number elements. Results obtained when using a special sample changer, x and alpha-ray source, and a windowless proportional counter are given for sodium, aluminum, silicon, and calcium in industrial samples. A short comparison of various ways of excitation is given for the analysis of high-atomic-number elements. Application is shown for lead-concentration measurements in pulps, and for tungsten-content measurements in steel. Industrial experiments are described for the continuous measurement of zinc coatings on iron sheets by x-ray fluorescence. Beta-ray excitation for analysis and coating measurements is discussed and results are given for various types of samples. A barium-133 source has been studied. Details are given on the spectrum observed with various detectors. Possible applications are considered. (auth)

256 (ORNL-IIC-10(Vol.2), pp 723-45) PRESENT STATUS OF RESEARCH AND APPLICATION OF LOW-ENERGY X- AND GAMMA-RAY SOURCES IN JAPAN. Kato, Masao (Tokyo Univ. (Japan). Inst. of Industrial Science).

X-ray absorptiometry using $^{3}H/Zr$ and $^{147}Pm/Al$ sources has been used to determine sulfur content in heavy oil at several electric power stations. The measurement of sediment suspended in water is now under study by means of gamma-ray absorption of ^{241}Am. Radioisotope x-ray-fluorescence technique has been in routine use for cement raw-mix control and is also being studied using $^{3}H/Zr$, ^{147}Pm, and ^{241}Am for several other uses. Further, experiments on preferential excitation method are being carried out, such as determination of nickel in Ni–Cu–Zn alloy by means of Zn–K_α ray which is produced by $^{147}Pm/Al$ source and zinc target. Analytical method using backscatter of ^{241}Am gamma ray is being applied to determine quantitatively ash in coal and Fe in iron ores. Thickness gauges using absorption of low-energy gamma rays of ^{241}Am, ^{155}Eu, and ^{170}Tm are being developed for the measurement of thin layers of Au plating on Ni and of Rh plating on Cu. The technique of the Mössbauer resonance absorption is being applied to investigate the chemical change induced by ionizing radiation, light, or heat and the electron configuration in various iron compounds. An attempt to apply Mössbauer spectrometry to the quantitative analysis of Fe^{2+} and Fe^{3+} in iron phosphate glass is now going on. Magnetic hyperfine splitting of iron has also been used for the investigation of magnetism and of the properties of magnetic compounds. Furthermore, metallurgical applications are starting. (auth)

257 (ORNL-IIC-10(Vol.2), pp 746-63) SOME APPLICATIONS OF LOW-ENERGY GAMMA AND X-RAY SOURCES IN POLAND. Ostrowski, K. W.; Gorski, L.; Niewodniczanski, J. (Academy of Mining and Metallurgy, Krakow (Poland). Inst. of Nuclear Technology).

Research in the field of radiometric analysis was undertaken in 1960 at the Institute of Nuclear Techniques in Cracow and later at the Institute of Nuclear Research in Warsaw. In the first work on nondispersive x-ray-fluorescence analysis, ^{170}Tm, T/Zr, $^{147}Pm/Al$, and $^{90}Sr/Pb$ sources were used. In 1964 the use of ^{55}Fe, ^{109}Cd, and ^{241}Am was introduced. Over the past six years, x-ray-fluorescence methods of analysis for the determination of metals in ores—copper, zinc, iron, and zirconium—have been developed. A method for the determination of calcium in cement mixes was recently developed, and one for rapid and precise tungsten determination in tool steel has been worked out. Two methods are routinely used in industry: determination of tungsten in tool steel and iron in iron ores. Absorption methods have also been developed, and some research has been done on the elimination of matrix effects and on nomographic interpretation of measurements of three-component materials. Interesting results have been obtained in the application of scattered low-energy gamma or x rays to the determination of iron in iron-bearing sands and of sulfur in hydrocarbons. The construction of special x-ray porportional counters with large windows permitted obtaining these results. (auth)

258 (ORNL-IIC-10(Vol.2), pp 764-85) THE DEVELOPMENT OF LOW-ENERGY PHOTON SOURCES IN THE UNITED KINGDOM. Ansell, K. H.; Stevenson, J. (Radiochemical Centre, Amersham (England)).

The growing interest in the use of low-energy electromagnetic radiation for gauging, radiography, chemical analysis, and instrument calibration has stimulated a rapid development of sources which emit radiation of energy 3–100 keV. Developments in the United Kingdom in the last three years are reviewed. The industrial use of the nuclides ^{55}Fe, ^{109}Cd, ^{241}Am, ^{170}Tm, ^{153}Gd, ^{57}Co is well established. ^{125}I and ^{131}Cs, which have shorter half-lives, are likely to be of interest mainly for medical applications. Secondary radiation may be produced by alpha, beta, and gamma excitation of characteristic x rays, and in the form of bremsstrahlung. Development of α-excited x rays has so far been based mainly on ^{210}Po, although this has an inconveniently short half-life. The initial interest in the use of ^{147}Pm and ^{90}Sr as beta sources for excitation has not been sustained, presumably because the technique of gamma excitation has become more widespread. Bremsstrahlung sources containing tritium and ^{147}Pm are also of growing importance, although there has been less demand for those containing ^{85}Kr, ^{204}Tl, and ^{90}Sr. The shape and size of a radiation source is governed by its ultimate use. Discs of aluminium or stainless steel containing ^{147}Pm, ^{241}Am, and ^{170}Tl are used for transmission techniques including radiography, thickness gauging, and absorption analysis. For backscatter techniques such as measurements of coating thickness and chemical composition, it is necessary to include a heavy metal backing in the source. A number of nuclides with energies from 3 keV (tritium–zirconium) to 122 keV (cobalt-57) have been used. For special applications, active areas in the form of a narrow line or a "point" may be required. Sources of 2 mm diameter with integral shielding in the form of a small gold cone have been used in source-target assemblies to produce substantially monochromatic x radiation for x-ray fluorescence techniques. For radiation of energy above 100 keV, the internal absorption in the radioactive matrix and external absorption in the capsule window are relatively small. At lower energies, the source must achieve a compromise between safety and efficiency. New applications requiring low-energy photons are still being found, and there are still some gaps in the energy range to be filled. As experimental techniques are adopted for industrial purposes, it is important that source designs of adequate safety are developed. (auth)

259 (ORNL-IIC-10(Vol.2), pp 786-804) APPLICATION OF X-RAY FLUORESCENCE TO THE AUTOMATION OF MAIL SORTING. Darigny, Etienne; Robin, Gerard (Atome Industriel, Chatillon-sous-Bagneux (France)).

The prototype x-ray fluorescence mail sorter was tested during a total of more than 500 hours passing about 10^7 letters with no trouble. A technician of the Post Office Administration was able to operate the unit and adjust all working parameters after short training, without previous knowledge of nuclear electronics. The stability of the circuits and the margin in threshold level allow on and off operation without difficulty. Some more testing is

necessary to fully evaluate the stability and useful life of proportional counters. Paper must be fabricated with zinc oxide which is easy, and the added cost to paper is a few percent of the paper value. The cost of the complete detecting system is of the order of $5,000. Technical specifications concerning speed and precision were met by this prototype. It is hoped that when all technical and economic data concerning the different principles tested are assessed, the final choice of the French Post Office Administration will be in favor of the x-ray-fluorescence system. Other applications to sorting and coding problems using in some cases several x-ray-fluorescent elements are at present under consideration. (auth)

260 (ORNL-IIC-10(Vol.2), pp 805-16) X-RAY FLUORESCENCE APPLIED TO THE MEASUREMENT OF ZINC COATING IN THE GALVANIZING INDUSTRY. Margolinas, Samuel (Nucleometre, Paris (France). Robertshaw Controls Co., Anaheim, Calif.).

An x-ray fluorescence gage which has been designed for the measurement of zinc coating on sheet steel is described. A discussion of the theoretical problems involved in the comparison of various methods now used for accomplishing this measurement is included and details of the construction are considered. For ranges of 50 to 210 g/m^2 and 160 to 350 g/m^2, measurements can be made with an accuracy of better than ±5%. These savings are such that a suitable gage can be amortized in 10 months. (auth)

261 (ORNL-IIC-10(Vol.2), pp 903-28) MEASUREMENT OF ASH CONTENT AND CALORIFIC VALUE OF COAL WITH RADIOISOTOPE INSTRUMENTS. Cameron, J. F. (International Atomic Energy Agency, Vienna (Austria)).

The relative merits of different radiation methods of measuring ash in coal are summarized. All depend on obtaining a sufficiently good correlation between the ash content or calorific value and the measured property of the coal. When the ash is of sufficient constant composition, all the methods may be used and the choice lies between the simplest methods. Measuring time is determined by sample preparation time but is generally a few minutes. Precision obtained with the neutron method is not yet known, as it awaits more extensive on-line measurements. In most cases only the total ash content is required which can be obtained with adequate accuracy by other radioisotope methods which are simpler and cheaper than the neutron method. If the composition of the ash varies, preference must be given to methods in which compensation can be achieved for these variations. All methods require some grinding and drying of the coal. With the backscatter method, the amount of grinding required decreases with increasing energy, but at the same time the effectiveness of compensation decreases with increasing particle size. Increasing the energy to about 20 keV will enable measurements to be made on coal of particle size less than about 1 cm, and, although the compensation will not be so good and the sensitivity is lower, it is possible that measurements will be obtained with adequate precision for the majority of coals. For high-ash coals, fuel ashes, and sinter feeds in the ash range 50 to 100%, transmission of electromagnetic radiation will probably be best. If the iron content varies, the energy should be below the Fe K absorption edge (7.11 keV), although this necessitates fine grinding of the samples. (F.S.)

262 (ORNL-IIC-10(Vol.2), pp 929-43) ROCK ANALYSIS BY ALPHA EXCITATION OF X RAYS. A POSSIBLE LUNAR PROBE. Adler, I.; Trombka, J. (National Aeronautics and Space Administration, Greenbelt, Md. Goddard Space Flight Center).

An x-ray spectrograph using alpha particle excitation of characteristic x-rays, proportional counter detection and pulse height analysis has been constructed and evaluated and a prototype of a flight instrument is presently being assembled. The reduction of the observed pulse height spectra to energy spectra is performed by Trombka's linear least squares analysis program. The results show excellent promise for classifying the common rock types. (auth)

263 ISOTOPE TARGETS FOR NUCLEAR RESEARCH. Bochin, V. P. (Inst. of Atomic Energy, Moscow). Isotopenpraxis, 3: 317-21(1967). (In Russian).

The technology of manufacturing free metallic foils in micron-scale thicknesses from the isotopes Fe, Cr, Ni, Zn, Os, Ru, and Pt is described. A method of reprocessing the isotopic materials is discussed and some possible materials losses are shown. (auth)

264 OUTLINE OF PROBLEMS SET BY RESEARCH AND CONSTRUCTION OF PACKAGING. Remy, J.; Labrousse, M. Energ. Nucl. (Paris), 9: 227-31(June-July 1967). (In French).

Factors which affect research on the packaging of large radiation sources are reviewed. The specific problems encountered in the construction of such packaging are examined in a general fashion. The solutions discovered for some specific points are defined. (J.S.R.)

265 ^{60}Co ROTATORY CONFORMATION TELETHERAPY UNIT. Takahashi, Shinji (Nagoya Univ., Japan); Kitabatake, Takashi; Nagai, Katsumi; Kurihara, Shigeyasu. Toshiba Rev., Int. Ed., No. 31, 38-45(July-Aug. 1967).

A new collimation device in a telecobalt therapy unit has been developed for conformation radiotherapy. The mechanism of this new collimation consists of 18 blades of diaphragm, cam mechanism, synchronizing rotation system including synchro-oscillator, beam focus radiographic apparatus, and cam profiling machine. By using this unit, all kinds of conformation therapy can be practiced, such as the irregularly moving-field technique, the hollow-out irradiation method, and the partially shielding moving technique. Treatment planning, procedure and iso-dose distribution are also discussed. (auth)

266 METHOD AND APPARATUS FOR UNDERWATER IRRADIATION OF SUBSTANCES. (to Atomic Energy of Canada Ltd.). British Patent 1,088,811. Oct. 25, 1967. Priority date Mar. 5, 1965, Canada.

A method and an apparatus are described for irradiating a substance with a radiation source under water. The substance to be irradiated is placed on a float, enclosed by a volume of gas and forced to sink under the water. The apparatus consists of the float, a bell which fits the float and also encloses the volume of gas, and a means to sink the float holding the substance to be irradiated, and the bell to a position under the water. (F.S.)

Materials Testing

Refer also to abstracts 202, 207, 217, 220, 247, 253, 649, 781, and 782.

267 (ANL-7334) NONDESTRUCTIVE INSPECTION OF EBR-II FUEL-JACKET TUBING USING ELECTROMAGNETIC TECHNIQUES. Busse, Thomas H.; Wood, Donald R.; Beyer, Norman S. (Argonne National Lab., Ill.). May 1967. Contract W-31-109-eng-38. 29p. Dep. CFSTI.

Approximately 136,000 ft of EBR-II fuel jacket tubing was inspected using eddy current techniques to eliminate all tubing that might prove detrimental when used. Quality requirements specified that wall defects or localized reduction of wall thickness equal to or greater than 10% of the wall thickness must be rejected. In the first inspection 22.48% of the 42,984 ft of welded tubing and 28.83% of the 13,925 ft of seamless tubing were rejected. After a different tube heat treatment there was only a 9% rejection. The long-term performance of the pulsed eddy current flow detector, which is described, is good. Equipment failures were minor and down time was minimal. (F.S.)

268 (BNWL-545) ACOUSTIC EMISSION BEHAVIOR OF ZIRCALOY-2 PRESSURE TUBING UNDER APPLIED STRESS. Michaels, T. E.; Fraser, M. C. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Sept. 1967. Contract AT(45-1)-1830. 14p. Dep. CFSTI.

The acoustic emission of Zircaloy-2 pressure tube material was studied during burst tests. Three material conditions were studied; as-received pressure tube material, as-received with addition of 275 ppM hydrogen, and irradiated material. (auth)

269 (BNWL-SA-1262) ACOUSTIC EMISSION IN METALS AS A NDT TOOL. Hutton, Philip H. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Sept. 1967. Contract AT(45-1)-1830. 15p. (CONF-671002-4). Dep. CFSTI.

From 27th National Fall Conference of the Society for Nondestructive Testing, Cleveland, Ohio.

The potential of acoustic emission as nondestructive testing and metallurgy research tools is discussed. Acoustic emission is the pressure wave produced by energy released by deformation and fracture. With adequate sensors and signal amplification, these pressure waves can be detected at the surface which is deforming or cracking. Applications include monitoring flaw growth in reactor pressure tubes; remote and continuous surveillance of operational systems, such as natural gas pipe lines, and aircraft structures to detect flaw formation and growth; monitoring welds for cracking during cooling; monitoring hydrostatic testing of missile fuel tanks; tool for fracture research in metallics and nonmetallics; and monitoring space vehicles for micrometeorite penetration. (F.S.)

270 (GEMP-555) STRESS-RUPTURE PARAMETERS: ORIGIN, CALCULATION, AND USE. Conway, J. B. (General Electric Co., Cincinnati, Ohio. Nuclear Materials and Propulsion Operation). June 30, 1967. Contract AT(40-1)-2847. 400p. Dep. CFSTI.

A review of the origin, calculation and use of the Larson–Miller, Dorn, Manson–Haferd, Graham–Walles, Murry, Brozzo, and Chitty–Duval parameters of stress–rupture is presented. These parameters are discussed using the Clauss, Larke and Inglis, and Murry evaluations and analyzed by the principle of Least Squares. A bibliography of 77 references is included. (F.S.)

271 (N-67-19360) DEVELOPMENT OF NONDESTRUCTIVE TESTING TECHNIQUES FOR HONEYCOMB HEAT SHIELDS. VOLUME II. LITERATURE, INDUSTRIAL SURVEY, AND BIBLIOGRAPHY. Martin, G.; Moore, J. F.; Rocke, J. W. (North American Aviation, Inc., Los Angeles, Calif.). Aug. 31, 1966. Contract NAS8-11733. 168p. (NASA-CR-82619; NA-66-912). CFSTI.

A literature and industrial survey of pertinent nondestructive testing techniques and equipment was conducted in support of a development program for nondestructive testing of honeycomb heat shields. Literature relating to ultrasonic, electromagnetic, radiographic, and other methods of nondestructive testing was collected, reviewed, and indexed. A partially annotated bibliography of pertinent literature was prepared and included with the reported survey results. The literature and industrial surveys, in addition to the contractor's conducted effort, were evaluated and formed the basis for the experimental nondestructive test development program. (STAR)

272 (NP-17075) A STATISTICAL ANALYSIS OF THE SHEAR STRENGTH OF REINFORCED CONCRETE BEAMS. Technical Report No. 78. Kennedy, Robert P. (Stanford Univ., Calif. Dept. of Civil Engineering). Apr. 1967. 256p.

Thesis.

The cracking shear strength (shear at which the first shear crack forms) and the ultimate shear strength of simple-supported and end-restrained reinforced concrete beams, both with and without web reinforcement were determined by statistical procedures consisting primarily of multiple regression analysis. Shape effect, tensile steel yield strength, and web reinforcement were not found to be significant variables. Ratio of measured cracking shear to predicted cracking shear was found to be approximately twice as large for end-restrained beams with a maximum moment ratio of unit than it was for simple supported beams. For simple-supported beams without reinforcement the ultimate concrete strength, the percentage of tensile reinforcement and the shear span to depth ratio are the important properties to be considered. (F.S.)

273 (TID-24103) EXPERIMENTAL STRESS ANALYSIS OF THE ATTACHMENT REGION OF HEMISPHERICAL SHELLS WITH ATTACHED NOZZLES. PART 2. RADIAL NOZZLE, 7.875 O.D.-7.125 I.D., 10.00 IN. PENETRATION. Maxwell, R. L.; Holland, R. W. (Tennessee Univ., Knoxville. Dept. of Mechanical and Aerospace Engineering). Apr. 1967. Contract W-7405-eng-26; Subcontract 2203. 290p. Dep. CFSTI.

Results of investigations to determine the stress patterns for the junction region of spherical shells with radially attached nozzles when subjected to internal pressure and various types of loadings on the nozzles are described. The tests were conducted on a hemisphere with a large radial nozzle of 7.875 in. OD and 7.125 in. ID and a 10 in. penetration into the hemisphere. Stress patterns were determined for the following five types of loadings: internal pressure applied to the hemisphere and nozzle assembly; an axial load applied collinear with nozzle; a pure bending moment, or couple, applied to the nozzle; a transverse or shear load applied normal to the nozzle; and a pure torque applied to the nozzle. The results of the experimental analysis are tabulated and normalized stresses versus vessel profile plotted for the various types of loads. (R.C.K.)

274 (NP-tr-1582) ON THE EFFECT OF PARTIALLY PERMEABLE INTERFACES IN ULTRASONIC TESTING. PART 1. THEORY. Mundry, E. Translated by A. G. Bowers (Atomic Energy Research Establishment, Harwell, Eng.), from Materialpruefung, 8: 433-44(1966). 36p. UK. DTIE.

A theory of multiple reflection in plane-parallel media with partially permeable interfaces is developed using echo height for an interface or intermediate zone in an interference free case, special cases of echo interference at locations of the partially permeable zone, and multiple reflections for several partially permeable zones. (F.S.)

275 MICROSCOPICAL ASSESSMENT OF CARBON REFRACTORY. Rutter, Frank (Steel Co. of Wales Ltd., Port Talbot). Trans. Brit. Ceram. Soc., 66: 423-41(Sept. 1967).

The significance of the high thermal conductivity of carbon and factors which influence this and other properties are discussed. The identification of different forms of carbon under the microscope is illustrated and a rapid means of identifying graphite and assessing degree of graphitization with the sensitive tint plate is described. The effect of heat-treating different forms of carbon to promote graphitization is discussed. A series of industrial carbon refractories based on graphite, anthracite, coal, petroleum coke, is illustrated and it is shown how the microscope can be used to identify constituents, determine any pre-treatment these constituents have had, and help in deducing special manufacturing techniques. Mechanisms of failure of carbon refractory are briefly discussed and the microstructure of carbon reaction products is described. (auth)

276 ON THE USE OF THE DOUBLE CANTILEVER BEAM SPECIMEN FOR DETERMINING THE PLANE STRAIN FRACTURE TOUGHNESS OF METALS. Hoagland, R. G. (Battelle-Northwest, Richland, Wash.). Contract AT(45-1)-1830. J. Basic Eng., 89: 525-32(Sept. 1967).

The double cantilever beam (DCB) specimen has considerable potential for application to fracture toughness testing because it facilitates the determination of a number of plane strain toughness data from a single specimen of moderate size. The relationship between the elastic strain energy release rate, load, and extension for a given crack length is obtained from compliance tests and the dependence of this relationship on the specimen geometry is presented. The effect of changing specimen geometry on the fracture toughness is also presented. Comparison with plane strain toughness data obtained by other techniques on identical materials is made to evaluate the effectiveness of the side grooves in the specimen for providing plane strain conditions at fracture. Finally, consideration of the meaning of the stress intensity at crack arrest in the DCB specimen indicates that this parameter is dependent on specimen geometry as well as the material properties. (auth)

277 RADIOGRAPHIC INSPECTION WITH THERMAL NEUTRONS. Rauch, Helmut; Saringer, Gerald. Materialpruefung, 8: 134-8(Apr. 1966). (In German).

The detectability of variations of plastic sheets between steel plates and the possibility of detecting hydrogen inclusions in steel were investigated. The neutrons penetrating the test material are captured by sensitive x-ray films, which are blackened to an extent of 60% by conversion electron radiation from thin gadolinium foil and 40% by direct gamma radiation. The neutron intensity at the location of measurements is approximately $2.0 \times 10^5/cm^2/sec$, the Cd ratio 19%, measured with 40 mg/cm^2 gold foil. Results show that variations in thickness of polyvinyl chloride plates may be detected to the extent of 0.7% in 15 mm, 1.5% in 20 mm and 5.5% in 40 mm. In the case of plastic sheets enclosed between steel plates, neutron irradiation produces usable images even with thick steel plates, while x-rays are significantly attenuated as a function of steel thickness. The detectability of hydrogen inclusions in steel was studied using grooves of varying depth filled with polystyrol material. Results are illustrated and compared with x-ray images of the same specimens. It was concluded that it is possible to use thermal neutrons for certain inspection applications that are outside the range of x-ray detection. (Rev. Met. Lit.)

Protective Structures

278 PLANNING ATOMIC SHELTERS: A GUIDEBOOK FOR ARCHITECTS AND ENGINEERS. Albright, Gifford H. (ed.). University Park, Pa., Pennsylvania State University Press, 1961. 203p. $10.00.

Information is presented which enables architects and planners to plan effective integrated shelters as a part of the design of selected building types. Basic principles of the philosophy of protection, the philosophy of integrated convertible shelters, weapons effects, and architectural planning are discussed as background for planning analyses and concepts for integrated convertible shelters. It is concluded that integrated convertible shelters can be incorporated within conventional spaces of buildings without decreasing the efficient performance of normal functions or creating windowless monstrosities, and at little or no increase in cost. The following building types are used as demonstrations: barracks, training school, administration building, 100 bed hospital, subsistence building, and communications building. (auth)

Radioactive Material Handling

Refer also to abstracts 264, 767, 1862, 1879, and 1907.

279 (AHSB(RP)R-79) ENVIRONMENTAL MONITORING ASSOCIATED WITH DISCHARGES OF RADIOACTIVE WASTE

DURING 1966 FROM U.K.A.E.A. ESTABLISHMENTS. Morley, F. (ed.) (United Kingdom Atomic Energy Authority, Harwell (England). Authority Health and Safety Branch). Aug. 1967. 20p. Dep. CFSTI. UK.

The results of the environmental monitoring undertaken to confirm that the discharges of radioactive waste during 1966 from each of the principal UKAEA establishments produced no hazard in the environment are described. The results of this monitoring are summarized and are compared with derived working limits to facilitate an appreciation of the standards of safety achieved. (auth)

280 (BNWL-SA-1388, pp 12.1-15) EXTERNAL RADIATION EXPOSURE CONSIDERATIONS. Faust, L. G.; Brackenbush, L. W. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

Information is included pertaining to the types and amounts of personnel exposure expected when processing the fuels and fuel materials for the Fast Flux Test Facility. (J.C.W.)

281 (CONF-661011, pp 11-28) RECENT DEVELOPMENTS IN REGULATIONS FOR TRANSPORTATION OF RADIOACTIVE MATERIALS. Brobst, William A. (Interstate Commerce Commission, Washington, D. C.).

The Interstate Commerce Commission, the Atomic Energy Commission, and the Bureau of Explosives of the Association of American Railroads have worked together in regulating transportation of radioactive materials. With the advent of new materials, the regulations for transport are being updated. The primary concern is safety to the personnel, public, and industry. (J.C.W.)

282 (CONF-661011, pp 120-31) ORO PROGRESS IN THE WITHDRAWAL AND PACKAGING OF ENRICHED UF_6 FOR TRANSPORT: ECONOMY AND SAFETY. McAlduff, Harold J.; Pryor, William A. (Oak Ridge Operations Office (AEC), Tenn.).

The withdrawal and packaging of enriched UF_6 for transport has primarily been influenced by criticality characteristics. Where these characteristics have been undefined, safety control parameters have necessarily been conservative resulting in noneconomical transport. With the completion of many experimental and theoretical studies, safety control has become more positive and realistic. To sustain the present momentum toward economic nuclear power all potential economies are required. With no compromise in safety, significant savings can be achieved by the bulk transportation of enriched UF_6. This balance in safety and economy is discussed. (auth)

283 (ORNL-4061) SAFETY STUDIES OF THE SHEAR-LEACH PROCESSING OF ZIRCALOY-2-CLAD SPENT NUCLEAR FUELS. West, G. A.; Watson, C. D. (Oak Ridge National Lab., Tenn.). Oct. 1967. Contract W-7405-eng-26. 14p. Dep. CFSTI.

A safety study of the handling of Zircaloy particles produced by a shear-leach processing of Zircaloy-clad nuclear fuels was conducted by means of a literature search and some abrasive disc sawing, shearing, and ignition tests. It was found that shear-leach processing can be accomplished safely. Dry zirconium powder is ignitable at room temperature by static electricity or simple friction and explodes spontaneously when dispersed into the air as a cloud. With a moisture content of 16% or less, it has on a few occasions exploded spontaneously while under vacuum. Violent explosions, which have occurred and produced fatal injuries, involved powders finer than 62 μ, or finer than 230 mesh size. When the surface area per gram approaches 0.1 m^2, caution must be exercised in powder handling. Particles finer than 20 mesh (800 μ) and coarser than 120 mesh (125 μ) should be collected wet (under water) and mixed with an equal volume of sand or grinding wheel grit. Tests showed that sawing can be done safely, provided large quantities (more than 1 to 2 kg) of the particles are not allowed to accumulate in the system. The Zircaloy-2 particles diluted with abrasive particles from wet sawing (the preferred method) at a minimum of three parts by volume is considered safe to handle and store. Particles produced by shearing are not converted to the oxide. Those less than 149 μ can be ignited by a Tesla coil. Particles resulting from shearing should be settled out and collected, following the leaching step, and chemically dissolved. (auth)

284 (SC-RR-66-677) THE ENVIRONMENT EXPERIENCED BY CARGO ON A FLATBED TRACTOR-TRAILER COMBINATION (ENVIRONMENTAL OPERATIONS ANALYSIS STUDY). Foley, J. T. (Sandia Corp., Albuquerque, N. Mex.). Dec. 1966. Contract AT(29-1)-789. 155p. Dep. CFSTI.

Truck-transport dynamic environment was measured during the shipment of a 15-ton radioactive materials cask from Wilmington, Delaware, to Albuquerque, New Mexico. This report of the trip describes the instrumentation, road conditions, vehicle speeds, and weather conditions encountered. Representative examples of the shock/vibration magnitudes that were measured are presented in reduced form, and a means is provided to apply these data to other loads which might be carried on the vehicle. (auth)

285 (SZS-10/67) GRUNDLAGEN DER NEUEN ANORDNUNG UEBER DEN TRANSPORT RADIOAKTIVER STOFFE IN DER DDR. (Basis for New Regulations for Transportation of Radioactive Material in DDR). Richter, D. (Staatliche Zentrale fuer Strahlenschutz, Berlin (East Germany)). July 1967. 31p. (In German). Dep.

New and uniform regulations for the transport of radioactive materials in East Germany now are effective, which are in conformity with the recommendations of the RGW and the IAEA in this field. The new regulations emphasize the safety requirements for the packaging of radioactive materials and facilitate earlier requirements concerning the carriage in the DDR. Fundamentals of radiation protection and safety are reviewed and the main packaging and transport requirements are summarized. (auth)

286 THE PROBLEM OF RADIOACTIVE WASTE STORAGE IN THE COMMUNITY. Grison, Gaston. Euratom Bull., 6: 84-8 (Sept. 1967).

Waste disposal problems in the nuclear industry are discussed, while a large part of the low- and medium-activity effluents are discharged into the surrounding air or water, the residues left after their decontamination, solid waste and contaminated objects are inconveniently bulky although generally of low radioactivity. In most cases they are stored in special areas at the production centers. The rapid, extensive development of nuclear power will result in a growing output of waste whose specific radioactivity will bear no relation to that of today's waste. Although satisfactory industrial solutions have been found for the processing and packaging of low-activity residues, the difficulties involved with highly radioactive waste are being widely discussed and the solutions recommended follow several lines of thought. Some advocate storage in liquid form for a period of several decades, deferring any better solution to a later day. Others recommend insolubilizing the waste with glass or ceramics by one of the numerous techniques being studied at present, while others again maintain that the recovery of certain fission products would substantially reduce the problems of processing and storage. (auth)

287 TRANSPORT OF RADIOACTIVE MATERIALS. Labrousse, M. Energ. Nucl. (Paris), 9: 221-68(June-July 1967). (In French).

The problems posed by the transportation of radioactive materials are reviewed with respect to packaging for the safe transport of radioactive materials. Individual abstracts were prepared of the 15 papers in which various aspects of this problem are considered. (J.S.R.)

For abstracts of individual papers see: 264, 288-299, 1796, and 1797.

288 REGULATION LIMITS OF THE PROBLEM OF PACKAGING DESIGN. Bouillet, J. Energ. Nucl. (Paris), 9: 222-7 (June-July 1967). (In French).

The safety principles in the design of packaging for the transportation of radioactive materials are outlined for the case where there is no danger of criticality and for the case where there is danger of criticality. The conditions under which these principles must be applied are described. (J.S.R.)

289 PACKAGING FOR THE TRANSPORT OF RADIOACTIVE MATERIALS. TWO EXAMPLES OF CONSTRUCTION OF THE TYPE B CASK. Kerjean, J.; Bernard, H. Energ. Nucl. (Paris), 9: 232-5(June-July 1967). (In French).

Two casks for the transport of large radioactive sources — G T 200 and EDF 3/3 weighing 50 metric tons — are described. Mechanical and thermal tests made on the G T 200 container are described. The security of the biological protection after the tests was determined. The design of the EDF 3/3 cask is described in detail. (J.S.R.)

290 PACKAGING FOR TRANSPORT OF RADIOACTIVE MATERIALS. CASKS FOR IRRADIATED FUEL: VARIOUS SOLUTIONS. Blum, P.; Lacheteau, H.; Lucas, H. Energ. Nucl. (Paris), 9: 235-41(June-July 1967). (In French).

The design of packaging for large radiation sources is conditioned by economic factors which take into consideration the tonnage limitations imposed by available manipulation machines, the means of transport adopted, and by security criteria imposed by safety regulations. The method in which these requirements have been satisfied is illustrated by descriptions of the casks designed for use at the Pegase, DM. 6 and Diorit. (J.S.R.)

291 PACKAGING FOR TRANSPORT OF RADIOACTIVE MATERIALS. CASKS OF LEAD, TRANSPORT, AND α,γ TRANSFER. Brisac, M.; Lefort, G. Energ. Nucl. (Paris), 9: 241-4 (June–July 1967). (In French).

Two casks for the transport and transfer of radioactive materials are described to illustrate the problems met by the design of casks and for which solutions have been developed. The first is a cask for the transfer-transport of experimental fuels and irradiated rods. The second cask was designed for the evacuation of radioactive wastes. (J.S.R.)

292 PACKAGING FOR TRANSPORT OF RADIOACTIVE MATERIALS. PACKAGING FOR THE STORAGE AND THE TRANSPORT OF FISSILE MATTER. Bracq, P.; Mauduit, B. Energ. Nucl. (Paris), 9: 244-5(June-July 1967). (In French).

The cooperative efforts of the Bracq-Laurent Society and the C.E.A. in the design and construction of cradles and packaging for the storage and transport of fissile matter are briefly outlined. (J.S.R.)

293 PACKAGING FOR TRANSPORT OF RADIOACTIVE MATERIALS. HEAT PROBLEMS POSED BY THE PACKAGING OF LARGE SOURCES. Labrousse, M.; Mordchelles-Regnier, G.; Michel, C.; Pirovano, A. Energ. Nucl. (Paris), 9: 245-51(June-July 1967). (In French).

The thermal problems in general and the natural convection in particular were studied and cooling of the transport casks for the fuel elements of the EDF 2, EDF 3, and EDF 4 reactors was calculated. The experimental verification of the calculation results was carried out on a mock-up. The results of the calculation were applied to the EDF 2, 3, and 4 casks. (J.S.R.)

294 PACKAGING FOR TRANSPORT OF RADIOACTIVE MATERIALS. TECHNICAL AND PRACTICAL DESIGN OF EXPENDABLE PACKAGING FOR RADIOELEMENTS. Vinarnick, L. Energ. Nucl. (Paris), 9: 251-6(June-July 1967). (In French).

The design of throw-away packaging for radioelements, primarily in liquid solution with relatively low radioactivity, is described. The factors to be considered in the selection of a particular expendable packaging are discussed. (J.S.R.)

295 TRANSPORT OF RADIOACTIVE MATERIALS. TRANSPORT OF RAW MATERIALS IN THE URANIUM INDUSTRY: ORES, CONCENTRATES, METALLIC URANIUM. Buret, R. Energ. Nucl. (Paris), 9: 257-9(June-July 1967). (In French).

Methods used for transportation of ores to processing plants, of preconcentrates and concentrates to processing installations, and of metallic uranium to fuel fabrication plants are briefly outlined, and the annual tonnage transported is indicated. (J.S.R.)

296 TRANSPORT OF RADIOACTIVE MATERIALS. ACTIVITY OF A SPECIALIZED COMPANY IN THE FIELD OF RADIOACTIVE MATERIALS TRANSPORT. Severo, J. P.; Bourdier, F. Energ. Nucl. (Paris), 9: 260-2(June-July 1967). (In French).

The services that a company specializing in the transportation of radioactive materials can offer are briefly outlined. These include packaging, economic studies of the most feasible methods and routes, preparation of convoys, operation of convoy transports, and road transports. (J.S.R.)

297 TRANSPORT OF RADIOACTIVE MATERIALS. ROAD TRANSPORT OF RADIOACTIVE MATERIALS. Chambragne, J. P.; Bernard, H. Energ. Nucl. (Paris), 9: 262-3(June-July 1967). (In French).

The design and characteristics of special vehicles for the road transport of radioactive materials are described. (J.S.R.)

298 TRANSPORT OF RADIOACTIVE MATERIALS. TRANSPORT OF RADIOACTIVE MATERIALS BY RAIL. Piquee, A.; Capet, H. Energ. Nucl. (Paris), 9: 263-5(June-July 1967). (In French).

The regulations applying to the rail transport of low activity matter and artificial radioelements and of irradiated fuel elements are reviewed. The regulations in the case of train accidents are indicated. (J.S.R.)

299 TRANSPORT OF RADIOACTIVE MATERIALS AND SAFETY. Sousselier, Y. Energ. Nucl. (Paris), 9: 266-8(June-July 1967). (In French).

The safety regulations in the transport of radioactivity materials are briefly outlined. The standards which a container must satisfy for large radioactive sources are indicated. (J.S.R.)

Vacuum Engineering

Refer also to abstract 213.

300 CRYOSORPTION PROPERTIES OF MOLECULAR SIEVES IN ULTRAHIGH VACUUM REGION. Nomoto, Taichi; Ishii, Hiroshi. Denki Shikensho Iho, 31: 745-50(June 1967). (In Japanese).

In the development of a cryosorption pump available in ultrahigh vacuum, the pumping performances were studied for the molecular sieves, 5A and 13X, at 77°K. The pumping speed has been measured on the adsorbent bed in the sample cell by the constant flow method for nitrogen gas in the pressure range of 10^{-6} to 10^{-8} torr. It was found that except at the initial adsorption stage which lasts for a few minutes after introducing the adsorbate gas, the pressure in the cell increases slowly and linearly in the square root of time. This pumping stage is called a steady pumping stage. The initial pumping speeds at the steady pumping stage for both 5A and 13X are very large and independent of the pressure in the region below 1×10^{-6} torr. However, the speed for 5A depends on the pressure in the region higher than 10^{-6} torr. The decay of speed for 5A is much faster than that of speed for 13X. The steady pumping speeds are independent of the thickness of the adsorbent bed, and are in proportion to the apparent area of the adsorbent bed. The decay of speeds in case of constant through-put is assumed to depend on the diffusion rate of adsorbed molecules into the interior of the adsorbent. The optimum condition of baking the molecular sieves is to heat them at 400°C for about 10 hours in high vacuum. (auth)

301 DESIGN AND PERFORMANCE OF CRYOPUMP. Akiyama, Yoshitane; Hashimoto, Hisako; Sato, Yoshimasa; Ishii, Hiroshi. Denki Shikensho Iho; 31: 735-44(June 1967). (In Japanese).

A cryopump which has a cryogenerator has been designed and developed. The cryogenerator consists of a single stage plunger type expansion engine which drives an oil pump or an induction motor as its load, several heat exchangers, and a liquid nitrogen container for pre-cooling helium gas. The whole system of the cryogenerator is set in a vacuum vessel. The pump head is connected with the cryogenerator by a vacuum cylinder which contains two cold helium pipes. The temperature of cryopanel in the pump head can be reduced to 9°K within a few hours after starting the expansion engine. The refrigeration capacity at 9°K is 90 watts. The ultimate pressure in a test dome is 1.8×10^{-8} torr. From mass spectrometric analysis, it is supposed that the hydrogen partial pressure has a direct influence on the ultimate pressure. The measured pumping speed is nearly equal to the theoretical one and remains constant even after the condensation of a large amount of air on the cold surface. The performance of this cryopump is satisfactory for the purpose. (auth)

INSTRUMENTATION

Radiation Detection Instruments

General Detectors and Monitors

Refer also to abstracts 91, 92, 170, 250, 262, 376, 1531, and 1598.

302 (AECL-2767) SINGLE CHANNEL SCINTILLOMETER FOR HEALTH PHYSICS. Jones, A. R. (Atomic Energy of Canada Ltd., Chalk River (Ontario)). Sept. 1967. 18p. Dep. CFSTI. CAN.

The single-channel scintillometer detects gamma rays of a particular energy, which can be selected efficiently. It detects other gamma rays inefficiently. It is small, rugged and operates from line power or internal rechargeable batteries. The mechanical construction, circuit operating principles, and some circuit details are described. Efficiencies for the detection of various isotopes and other performance data are presented. The application to problems in health physics is discussed. An appendix explains the operation and maintenance. (auth)

303 (ANL-7224) WIDE-RANGE COUNTING-CAMPBELLING NEUTRON-FLUX DETECTION SYSTEM. Popper, G. F.; Lipinski, W. C.; Harrer, J. M. (Argonne National Lab., Ill.). Apr. 1967. Contract W-31-109-eng-38. 45p. Dep. CFSTI.

A neutron-detection system that uses a single fixed-position neutron detector to continuously monitor up to ten decades of reactor power was assembled and tested. The system had good gamma discrimination over the entire neutron-flux range. A conventional counting technique was used to cover the source and low intermediate ranges, and a statistical chamber current fluctuation technique (Campbelling System or Mean Square Voltage System) was used to monitor the intermediate and power ranges. The system's response to neutron flux and the change in the system's response, when different cables were used between the detector and preamplifier, were measured. In addition, some of the basic parameters of a standard fission counter were also measured. (B.G.D.)

304 (BNWL-430) REACTOR IN-CORE REGENERATIVE NEUTRON DETECTORS INTERIM DEVELOPMENT REPORT. Jackson, C. N. Jr. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Oct. 1967. Contract AT(45-1)-1830. 20p. Dep. CFSTI.

In order to circumvent the problems of rapid performance degradation and other limitations of nuclear reactor in-core neutron flux detectors operating at high thermal neutron flux levels, development of regenerative ^{234}U-^{235}U detectors is being conducted. The sustained, relatively constant sensitivity of two experimental detectors, inserted within the core of a Hanford plutonium production reactor, demonstrated that extension by a factor greater than ten in the useful in-core life can be achieved with a regenerative emitter material as compared to a typical fission chamber. The sensitivity remained within essentially 10% of a medium value throughout an exposure of 5×10^{21} nvt for a calculated optimum regenerative emitter formulation of about 10% ^{235}U and 90% ^{234}U. This performance is equivalent to more than ten years operation in a possible nuclear commercial reactor having a neutron flux level of 1×10^{13} nv. Typical of fission chambers, these experimental devices exhibited a robust signal strength, prompt response, and a dynamic range of about four decades. The detector sensitivity was about 1×10^{-16} A per nv for thermal neutron and about 8×10^{-13} A per R/hr for gammas with a chamber sensitive volume one inch in diameter by one inch in length. Noted reductions in chamber dielectric characteristics were attributed to deficiencies in the test chamber vehicle. To demonstrate the practicality of these regenerative chambers for use in the nuclear industry and to overcome the dielectric problems, a second test capsule has been prepared using commercially fabricated detectors. This capsule will be irradiated in the ETR at the National Reactor Test Site in a thermal neutron flux level of about 4×10^{15} nv. A comprehensive test package, this capsule includes ten individual detectors and will permit comparative performance evaluation of regenerative, ^{235}U, gamma and rhodium beta current devices. The test capsule features chambers of nearly identical design, differing principally in the material contained within the detectors. (auth)

305 (CEX-59.4(Pt.4)) AERIAL RADIOLOGICAL MEASURING SYSTEM. PART IV. EQUIPMENT AND PROCEDURES THROUGH FISCAL YEAR 1966. Trundle III, A. S.; Story, E. J. (Edgerton, Germeshausen and Grier, Inc., Santa Barbara, Calif.). Mar. 1966. Contract AT(29-1)-1183. 57p. (EGG-1183-2083). Dep. CFSTI.

The Aerial Radiological Measuring System (ARMS-II) operated by EG&G, Inc., for the Division of Biology and Medicine, U. S. Atomic Energy Commission, is described. Designed to measure radioactivity over large areas, the ARMS-II system consists of sodium iodide scintillation detectors, radiation- and positioning-measuring instruments, and data-readout instruments. The methods of operation and data interpretation are discussed and evaluated, and recommendations are made for further improving the system. (auth)

306 (COO-1422-10) NEW BONE MINERAL SCANNERS. Judy, Philip; Sadrzadeh-Raffii, Ali; Cameron, John R.; Sorenson, James A. (Wisconsin Univ., Madison. Dept. of Radiology). Aug. 1, 1967. Contract AT(11-1)-1422. 13p. Dep. CFSTI.

A description of scanners developed to determine the bone mineral content of humerus, femur, and as calcis is presented. The linear humerus scanner was also used to make preliminary measurements on the tibia and fibula. (B.G.D.)

307 (COO-1422-14) INSTRUCTION MANUAL FOR SEMI-AUTOMATIC BONE MINERAL MEASURING SYSTEM. Witt, Robert; Judy, Philip; Cameron, John R.; Sorenson, James A. (Wisconsin Univ., Madison. Dept. of Radiology). Aug. 1, 1967. Contract AT(11-1)-1422. 11p. Dep. CFSTI.

A semi-automatic bone mineral measuring system is described. To measure bone mineral in vivo, the differences in transmission of a monoenergetic photon beam (^{125}I) through bone tissues and soft tissues were determined. The measuring system consisted of three major components: the mechanical scanner, a spectrometer, and three output devices. The output mode of the system is described. (B.H.S.)

308 (N-67-19359) NEUTRON MULTIPLICITY MONITOR OPERATIONS AT SEA LEVEL AND 3800 METER ELEVATION. Final Report, June 22, 1965-June 22, 1966. Nobles, R. A.; Alber, R. A.; Hughes, E. B.; Newkirk, L. L.; Reynolds, G. T.; (and others) (Lockheed Missiles and Space Co., Palo Alto, Calif. Research Labs.). Contract NASw-1240. 91p. (NASA-CR-82597). CFSTI.

The neutron multiplicity monitor, a unique type of cosmic ray neutron monitor designed for the efficient exploitation of the energy dependence of multiple neutron production, is described. Operating deep in the atmosphere, its purpose is to obtain information on the energy spectrum of the incident secondary cosmic radiation. This monitor differs from the ordinary type because of its higher intrinsic efficiency (i.e., it counts a larger fraction of the internally produced neutrons), and its greater target thickness allows operation more nearly as a total energy detector. It also has electronic circuitry for multiplicity measurements. This monitor is unique in that it gives intensity information similar to an ordinary monitor and, in addition, yields information on energy spectrum variations. (STAR)

309 (ORNL-IIC-10(Vol.2), pp 557-73) PROGRESS IN INSTRUMENTATION FOR SOFT X-RAY SPECTROSCOPY. Baun, W. L.; Fischer, D. W. (Air Force Materials Lab., Wright-Patterson AFB, Ohio).

Progress in instrumentation for x radiation in the region 5 to 150 Å is discussed. Recent work in the Air Force Materials Laboratory in the production, dispersion, and detection of soft x radiation, and a general summary of the state-of-the-art in soft x-ray spectroscopy is presented. (W.H.K.)

310 (ORNL-IIC-10(Vol.2), pp 817-42) PORTABLE X-RAY FLUORESCENCE ANALYZER. Tolmie, R. W. (Atomic Energy of Canada Ltd., Ottawa (Ontario). Commercial Products Div.).

Radioisotope x-ray fluorescence gages, made in a compact, simple-to-use form, which makes them suitable for portable use or for multiple stations in factories, are described. Scintillation detectors are used for lightweight portable analyzers, but the higher resolution of solid-state and proportional counters makes them advantageous for on-line industrial applications in which there are interfering element effects. Microcircuit devices are available which make it possible to construct simple, stable electronic pulse-height analyzers in miniature form, utilizing digital ratemeters to achieve the highest precision and minimum analysis time. (auth)

311 (ORNL-IIC-10(Vol.2), pp 944-62) RADIOMETRIC ANALYSES WITH HIGH-YIELD PROPORTIONAL X-RAY COUNTERS AND LOW-ACTIVITY SOURCES. Ostrowski, K. W.; Jelen, K.; Rulikowska, E. (Academy of Mining and Metallurgy, Krakow (Poland). Inst. of Nuclear Technology).

A review of work on the application of x radiation in radiometric analysis is presented. Some criteria for the proper choice of radioisotope sources are discussed, and properties of the detectors constructed are described. Some examples of analyses (iron and copper ores, sulfur in hydrocarbons) using the specially chosen sources and detectors are described. Improved geometrical arrangements are also discussed. (auth)

312 DEVICES FOR MEASURING SMALL DIRECT CURRENTS AND DEVICES FOR CHECKING THE PRECISION OF MEASUREMENTS. Antonova, D. I.; Rozhdestvenskaya, T. B. Izmer. Tekh., No. 9, 60-7(Sept. 1967). (In Russian).

A brief review is given of various methods and devices for measuring direct currents from 10^{-9} to 10^{-15} A and of various methods for checking and evaluating the precision of the measuring instruments. The performance of these various instruments are discussed. (R.V.J.)

313 PROBLEMATICS ON THE APPLICATION OF DELAYED COINCIDENCE DEVICES. Eissa, N. A.; Mate, Gy. (Nuclear Research Inst., Debrecen, Hungary). Acta Phys. Acad. Sci. Hung., 23: 259-76(1967).

The most important features of coincidence circuits and experiments that can be carried out with these circuits are discussed. Coincidence circuit parameters such as the setting of the delay and and of the resolving time are discussed. Problems appearing during the application of the normal and sum coincidence are presented. Finally, a description is given of the application of the coincidence circuits for particle identification, for pile up elimination, and for measuring low-energy gamma rays. (auth)

314 RADIATION RESISTANT SILICON DIODE NEUTRON DETECTORS. Epstein, L. M.; Ferber, R. R. (Westinghouse Research Labs., Pittsburgh). Nucl. Appl., 3: 692-8(Nov. 1967).

Low-resistivity (10Ω-cm) silicon diodes were employed as fast-neutron monitors, using a ^{238}U conversion foil. Resolved fission spectra were recorded in-pile at a fast-neutron flux of $\approx 10^{11}$ n/(cm^2 sec) and up to an integrated flux of 4.6×10^{15} fast neutrons/cm^2. Preamplifiers designed especially for this work included a bias supply of very low dc impedance because of the large leakage currents in the radiation-damaged diodes. Despite this leakage, the damaged diodes were not very noisy and could withstand more bias (≈45V) than the undamaged diodes. (auth)

315 DETECTION OF CHARGED PARTICLES WITH HIGH RESOLVING POWER. Meynadier, C.; Kamert, J. C. (Institut d'Etudes Nucleaires, Algiers). Nucl. Instrum. Methods, 56: 136-40(Nov. 1967). (In French).

An ensemble detector-preamplifier for detection of charged particles is described. Improvement of the resolution is attained by cooling detector and input stage of the preamplifier in which use is made of a field effect transistor. Results are given for the reactions $^{20}Ne(d,p)^{21}Ne$ and $^{20}Ne(d,\alpha)^{18}F$ on gaseous targets. (auth)

316 LARGE-AREA SCINTILLATION DETECTOR USED IN AN EXTENSIVE SHOWER EXPERIMENT. Catz, Ph. (CNRS, Verrieres le Buisson, France). Nucl. Instrum. Methods, 56: 74-6(Nov. 1967). (In French).

The performance of a large area liquid scintillator detector used in an extensive air shower experiment is described. A single photomultiplier permits the simultaneous measurement of the electron density in an extensive air shower and the instant of its arrival. (auth)

317 PULSE HEIGHT DEFECT DUE TO ELECTRON INTERACTION IN THE DEAD LAYERS OF Ge(Li) γ-RAY DETECTORS. Strauss, M. G.; Larsen, R. N. (Argonne National Lab., Ill.). Nucl. Instrum. Methods, 56: 80-92(Nov. 1967).

Gamma rays giving rise to ionizing electrons in the dead layer of Ge(Li) detectors result in slow pulses of reduced amplitude which degrade energy spectra and coincidence resolution. It is shown that when internal conversion electrons from ^{207}Bi (~1 MeV) impinge on a detector with a thin dead layer of 10 μm, the peaks characteristic of the K and L electrons are well defined; but when they impinge on a detector with a lead layer of 0.3 mm, the electron spectrum shows no features except a continuum which rises at the low energy end. The distribution of risetimes, resulting from the interaction of conversion electrons in the latter detector, exhibits a peak which indicates an abundance of slow pulses. A similar peak is apparent in the risetime distribution from γ-rays in the continuum of the energy spectrum but not from γ-rays in the full energy peak. This suggests that a significant fraction of the pulses in the continuum is due to electron and/or positron interaction in the dead layers. A pulse shape discrimination technique was developed whereby defective pulses are identified and rejected. Gamma-ray spectra from a single Ge(Li) detector and from a Ge(Li)–NaI(Tl) 3-crystal pair spectrometer were studied. A comparison of these spectra with and without rejection of slow pulses shows that in an 11 mm thick detector the fraction of the continuum due to defective pulses approaches 50%. The discrimination technique is described and results of several experiments are presented and discussed. (auth)

318 A CORRECTED OPTICAL SYSTEM FOR WIDE ANGLE CHERENKOV LIGHT. Leontic, B. A. (Brookhaven National Lab., Upton, N. Y.). Contract AT(30-2)-Gen-16. Nucl. Instrum. Methods, 56: 32-44(Nov. 1967). (BNL-11293).

A catadioptric system for the focusing of wide-angle Cherenkov light is described. Both geometrical and chromatic aberrations are corrected substantially by a combination of a plano-convex lens and a spherical mirror. In this special case the two radii of curvature are identical and the spherical surfaces are in optical contact. (auth)

319 MONTE CARLO AND S_n CALCULATIONS OF THE EFFICIENCY OF ^6Li LOADED GLASS DETECTORS. Cameron, J.; Harrison, L. M.; Parker, J. B. (Atomic Weapons Research Establishment, Aldermaston, Eng.). Nucl. Instrum. Methods, 56: 45-54(Nov. 1967).

The efficiency of ^6Li loaded glass scintillation detectors is calculated both by Monte Carlo and S_n methods, the method of adjoints being exploited in the latter series of calculations. The impact of the results of the calculation on detector design is discussed. (auth)

320 MANUFACTURE OF THICK LITHIUM-DRIFTED SILICON DETECTORS. Ristinen, R. A.; Lind, D. A.; Homan, J. L. (Univ. of Colorado, Boulder). Contract AT(11-1)-535. Nucl. Instrum. Methods, 56: 55-60(Nov. 1967). (COO-535-565).

A method is described which is used in the manufacture of thick lithium-drifted silicon radiation detectors for use in nuclear physics experiments at the University of Colorado cyclotron laboratory. An effort was made to simplify and reduce in number the usual procedures of detector manufacture. The counters which are produced by this method are operated either at room temperature or at dry ice temperature and are of a quality comparable to that of the best detectors available. (auth)

321 DETECTION OF UV RADIATION BY AN ELECTRON CHANNEL MULTIPLIER. Martin, K. S.; Martelli, G. (Univ. of Sussex, Eng.). Nucl. Instrum. Methods, 56: 173-4(Nov. 1967).

The response in the uv long wave region of a channel multiplier Mullard B4B has been measured using a mercury discharge. It has been found that this type of channel multiplier still detects clearly the lines at 3300 Å. (auth)

322 SHADOW-BAR DESIGN FOR FAST-NEUTRON SCATTERING EXPERIMENTS. Hopkins, J. C.; Martin, J. T.; Seagrave, J. D. (Los Alamos Scientific Lab., N. Mex.). Contract W-7405-eng-36. Nucl. Instrum. Methods, 56: 175-6(Nov. 1967). (LA-DC-8930).

The criteria for shadow-bar design and material selection for fast-neutron scattering experiments are discussed. A technique for automatic shadow-bar placement is described. (auth)

323 HIGH RESOLUTION PARTICLE-DETECTORS PRODUCED BY ION-IMPLANTATION. Meyer, O.; Haushahn, G. (Kernforschungszentrum, Karlsruhe, Ger.). Nucl. Instrum. Methods, 56: 177-8(Nov. 1967).

High resolution particle detectors are produced by ion-implantation technique. It is shown that the improved performance is due to the fact that well-channeled ions at relative low energy and low ion-concentrations minimize bulk damage effects. (auth)

324 INFLUENCE OF LEAD IMPURITY ON THE SCINTILLATION PERFORMANCE OF NaI(Tl) CRYSTALS. Schulz, G.; Breiter, G. (Univ., Heidelberg). Nucl. Instrum. Methods, 56: 179-80(Nov. 1967).

Pb^+ centers in NaI(Tl) absorb the fluorescence radiation, thus deteriorating the energy resolution of big crystals appreciably. This effect is studied quantitatively. (auth)

325 TO WHAT EXTENT IS IT DESIRABLE TO REDUCE THE HALF-WIDTH OF THE DETECTOR IN MEASURING γ ACTIVITIES? Potschwadek, B. (Univ., Rostock, Ger.). Atompraxis, 13: 352-3(Aug. 1967). (In German).

Equations which were set up in an earlier study are used here to indicate to what extent a reduction of the fwhm of a particular detector has a favorable effect on counting statistics. This possibility is especially useful when the preparation effect is equal to or less than the background. (auth)

326 DETERMINATION OF THE RADIOACTIVITY OF ROCKS BY γ SPECTROMETRY USING A Li-COMPENSATED Ge DETEC-

TOR. Mathevon, Gilbert; Rothe, Jean-Pierre; Siffert, Paul; Coche, Andre (Institut de Physique du Globe, Strasbourg. Centre de Recherches Nucleaires, Strasbourg). Compt. Rend., Ser. A and B, 264: 1753-6(June 19, 1967). (In French).

The possibility of determining the content of radioelements (U and Th) in rocks by γ spectrometry with a Li-compensated Ge diode was studied. This method was applied to three granites from Vosges. (tr-auth)

327 NEW SOLID DETECTORS OF NUCLEAR TRACES AND NEW METHODS OF CHEMICAL DEVELOPMENT OF DETECTORS ALREADY KNOWN. Besson, Henri; Monnin, Michel; Sanzelle, Serge (Faculte des Sciences, Clermont-Ferrand, France). Compt. Rend., Ser. A and B, 264: 1751-2(June 19, 1967). (In French).

The possibility of using six new organic polymers for the recording of charged particle tracks and the utilization of different reagents (potassium dichromate and potassium permanganate) for previously known detectors is indicated. The six organic polymers suggested are polyethylene, ionomeric polyethylene, polypropylene, polyphenoxide, polyvinylacetyl chloride, and polyvinyl chloride–polyvinylidene. (J.S.R.)

328 MEASUREMENT OF LOW ALPHA-ACTIVITIES USING THE SPARK COUNTER. Saro, S.; Srkalova, V. (Comenius Univ., Bratislava). Nucl. Instrum. Methods, 56: 254-60(Nov. 1967).

The possibility of using a wire-plane spark counter with air filling at atmospheric pressure for the precise measurement of low alpha activities by presence of other types of radiation was investigated. For this purpose some important properties of such a counter were examined. A moderate dependence of the efficiency of the counter on the concentration of the water vapor in air was found. Also, that the maximal efficiency is reached about a relative humidity of 50 to 70%. The width of the sensitive region of the counter does not depend very much on the anode wire diameter. The change of wire diameter from 0.03 mm to 2 mm changes the width of the sensitive region twice. A strong angular dependence for all the configurations of electrodes has been found. Spark counters can be used for the precise determination of low alpha activities for samples which differ from the alpha standard only by their activity. (auth)

329 DISPLAY OF STATISTICAL DATA FROM NUCLEAR COUNTING EXPERIMENTS. Hooton, I. N. (United Kingdom Atomic Energy Authority, Harwell, Eng.). Nucl. Instrum. Methods, 56: 277-83(Nov. 1967).

Many nuclear experiments measure the relative probability of different events occurring at random. The results obtained are displayed as histograms on cathode ray tubes both during and after the experiment. A comparison is made between the precision of the data and of the display for linear, logarithmic, and square root relationships between the data and the display. It is suggested that a square root law is the most appropriate for the display of statistical data. (auth)

330 MEAN RATE ANALYSIS OF MULTICHANNEL NUCLEAR DATA. Hooton, I. N.; Best, G. C. (United Kingdom Atomic Energy Authority, Harwell, Eng.). Nucl. Instrum. Methods, 56: 284-8(Nov. 1967).

A method of multichannel analysis is proposed in which the mean rate in each channel is presented directly as counts per unit time interval, independent of the total experimental time. The method may also be applied to the direct representation of relative probability. Essentially the total storage capacity of a mean rate analyser is divided into two independent halves. One half contains the latest assessment of the mean rate per channel and is coupled to the display system, while the other half contains the counts currently being collected and has random access from the data input. Because the two halves have different functions and rates of working it is possible to combine different storage media to provide optimum operation at minimum cost. In computer applications the method reduces both program complexity and execution time on machines having short word lengths. It also permits half the total bit capacity required to be provided by a suitable drum store. The display provided is essentially static in amplitude but has increasing precision as the experiment continues. (auth)

331 MULTIPARAMETER PULSE-HEIGHT ANALYSIS PROGRAMS. Norbeck, E.; Mancusi, M. D. (Univ. of Iowa, Iowa City). Nucl. Instrum. Methods, 56: 293-300(Nov. 1967).

An extensive set of programs for a large computer has been developed to process the magnetic tape output of a small on-line computer. The two computers together constitute a very versatile general purpose multiparameter pulse-height analysis system. The programs are written in the FORTRAN IV and MAP programming languages for the University of Iowa's IBM 7044 digital computer. The on-line computer is a CDC 160A. (auth)

332 CHARGE DIVIDING MECHANISM IN POSITION SENSITIVE DETECTORS. Kalbitzer, S.; Melzer, W. (Max Planck Institut fuer Kernphysik, Heidelberg). Nucl. Instrum. Methods, 56: 301-4(Nov. 1967).

The principle of operation of the one-dimensional position-sensitive detector is investigated by means of a simple model describing the detector as a line of a continuously distributed junction capacitance C and resistance R of the back layer. It is shown that a linear relationship exists between the position of the incident particle and the total charge collected at the position contact of the detector. The kinetics of the charge collected at the position and energy contact were computed. The rise times of the charge pulses (10 to 90%) are found to vary with the position of incidence up to about RC/4 sec. (auth)

333 AN EMPIRICAL METHOD FOR DETERMINING THE RELATIVE EFFICIENCY OF A Ge(Li) GAMMA-RAY DETECTOR. Kane, W. R.; Mariscotti, M. A. (Brookhaven National Lab., Upton, N. Y.). Contract AT(30-2)-Gen-16. Nucl. Instrum. Methods, 56: 189-96(Nov. 1967). (BNL-11517).

An empirical method for determining the full-energy peak efficiency between 0.2 and 3.0 MeV and the two-escape peak efficiency between 2 and 9 MeV of a Ge(Li) gamma-ray detector is described. The full-energy peak efficiency is determined with the use of several nuclides which emit gamma rays with accurately known intensity ratios and a linear least-squares fitting procedure. With the full-energy peak efficiency determined, a number of high and low energy thermal neutron capture gamma ray cascades with known relative intensities are then utilized in the determination of the two-escape peak efficiency. (auth)

334 APPLYING THE METHOD OF PREDICTION ANALYSIS TO THE PROBLEM OF PEAK SEPARATION. Wolberg, J. R. (Israel Inst. of Tech., Haifa). Nucl. Instrum. Methods, 56: 209-12(Nov. 1967).

Prediction analysis is a method for predicting the accuracy of experimental results as a function of the experimental variables and parameters. The method is useful for the design and planning of experiments. The method is described and then applied to the problem of peak separation for which the purpose of the experiment is to determine the unknown amplitudes of two overlapping peaks. This problem is important in such areas as neutron cross section and gamma ray spectroscopy. Results useful for the design of such experiments are included in a dimensionless form. (auth)

335 FAST-GATED PULSE-HEIGHT DISCRIMINATOR WITH SMALL-TIME SLEWING. Grieder, P. K. F. (Univ. of Bern). Nucl. Instrum. Methods, 56: 229-33(Nov. 1967).

A fast-gated pulse-height discriminator is described with particular emphasis on small-time slewing. The maximum delay variation versus input pulse height obtained for mercury relay pulses amounted to 1.5 ns. The unit covers a fully linear threshold range from 100 to 5100 mV with the aid of a special linearizing circuit, including temperature compensation. It provides fast rising negative output pulses of well defined width, suitable for further logic functions, and positive pulses for scaling. The fast gate acts as an ON or OFF gate. Its jitter is approximately 1 ns. Thorough performance tests were carried out and detailed characteristics are presented. A modified version with a dc input is also discussed. (auth)

336 A NOTE ON $\Delta E \cdot E$ PARTICLE DISCRIMINATION. Homeyer, H. (Hahn–Meitner-Institut fuer Kernforschung, Berlin). Nucl. Instrum. Methods, 56: 355-6(Nov. 1967).

An improvement in particle discrimination is described obtained by a modified operation of a circuit by Radeka. (auth)

337 LARGE VOLUME LITHIUM-DRIFT DIODES. Tavendale, A. J. (to Atomic Energy of Canada Ltd.). Canadian Patent 759,633. May 23, 1967.

Large volume lithium-drift diode detectors may be produced as follows. Lithium is diffused onto at least two surfaces of a crystal of p-type material. One surface and the two opposing end surfaces do not receive a coating. A bias voltage is applied between the lithium-coated surfaces and a contact placed centrally on an end surface not diffused with lithium. In a controlled atmosphere, heat is applied such that drifting takes place inwardly from the lithium-diffused surfaces leaving a coaxial core of p-type material of small size in the central region. The drift time is reasonable. (F.S.A.)

338 WINDOWLESS HIGH-RESOLUTION SOLID STATE RADIATION DETECTOR. Armantrout, Guy A.; Camp, D. C. (to U. S. Atomic Energy Commission). U. S. Patent 3,351,758. Nov. 7, 1967.

A large volume, highly sensitive, solid-state radiation detector of the class characterized by an intrinsic region separating positive and negative-type impurity doped regions is described. Specifically, the invention discloses a method for greatly increasing the width of the intrinsic region between the opposingly doped impurity regions, wherein the resulting volume of intrinsic semiconductor material is subtended by a substantially larger surface area than is correspondingly subtended by the positive and negative doped end regions. The resulting semiconductor detector provides a heretofore unobtainable large radiation collection surface area, together with extremely low capacitance between the opposingly poled, impurity doped end regions. (AEC)

Nuclear Spectroscopic Instrumentation

339 (HMI-B-59) UNTERSUCHUNGEN ZUR DIFFERENZ-γ-SPEKTROMETRIE. (Studies on Difference-γ-Spectrometry). Altenhein, F. K. (Hahn-Meitner-Institut fuer Kernforschung, Berlin (West Germany)). Aug. 1967. 119p. (In German). Dep.

Difference-γ-spectrometry is investigated experimentally and theoretically. Difference-γ-spectra are computed by the Monte-Carlo method and with experimental results for the scintillator combinations NaI/anthracene and NaI/plastic NE 102 A. The optimum arrangement of a difference-γ-spectrometer is discussed. (auth)

340 (IS-1701) OPERATION OF AN X-RAY AND A NEUTRON DIFFRACTOMETER CONTROLLED BY A NON-DEDICATED COMPUTER SYSTEM. Dahm, D. J.; Benson, J. E.; Nimrod, D. M.; Fitzwater, D. R.; Jacobson, R. A. (Ames Lab., Iowa). Oct. 1967. Contract W-7405-eng-82. 9p. Dep. CFSTI.

The x-ray and neutron diffractometers under discussion are Hilger and Watts four-circle devices. Simultaneous control of these and other instruments is accomplished with a real-time computer system consisting of an SDS 910 computer linked to magnetic disks by an IBM 1401 computer. The operation of this system is discussed and compared with other automated systems currently in operation. A complete set of programs for data collection including crystal alignment, generation of indices and angles, monitoring of standard reflections, and measurement of peaks and backgrounds have been written. Each program handles only a small portion of the task; additions or substitutions of programs are therefore easily implemented by the user to change the mode of operation. The same set of programs may also be recombined by writing one short calling program. (auth)

341 (KFKI-8/1967) A SINGLE CRYSTAL SLOW NEUTRON SPECTROMETER AT THE PULSED REACTOR IN DUBNA. Gordon, J.; Pellionisz, P.; Vizi, I.; Zsigmond, G.; Szkatula, A. (Magyar Tudomanyos Akademia Kozponti Fizikai Kutato Intezete, Budapest). 1967. 14p. Dep.

A spectrometer built for combination of monocrystal and time-of-flight techniques is described. The wavelength resolution is 1.5%, while the time resolution of the spectrometer is 18 μsec/m with normal water and 25 μsec/m with the polyethylene-beryllium cooled moderator. For the latter the slow neutron flux at the sample is 30 neutrons/cm^2 sec. The background is less than 0.6 neutrons/hour for 16 μsec channel width on a detector surface of 250 cm^2. As an example of application the distribution curve for critical scattering on iron is presented. (auth)

342 (ORNL-IIC-10(Vol.2), pp 522-56) TECHNIQUES OF LOW-ENERGY X-RAY AND ELECTRON PHYSICS: 50 TO 1000 eV REGION. Henke, Burton L. (Pomona Coll., Claremont, Calif.).

A considerable amount of interest has developed in recent years in the application of the ultrasoft x-radiations to light-element determination (Mg through Be), valence band analysis, high temperature plasma diagnostics, x-ray astronomy, x-ray microscopy, and long wavelength x-ray diffraction. Some of the methods and instrumentation which have been developed over the past ten years for research in low energy x-ray and electron physics are summarized. (auth)

343 (ORNL-4118) ESTABLISHING AN ENERGY SCALE FOR PULSE-HEIGHT DISTRIBUTIONS FROM GAMMA-RAY SPECTROMETERS BASED ON INORGANIC SCINTILLATORS. Peelle, R. W.; Love, T. A. (Oak Ridge National Lab., Tenn.). Oct. 1967. Contract W-7405-eng-26. 63p. Dep. CFSTI.

Devices, experiment designs, and data analysis techniques useful for the calibration of scintillation gamma-ray spectrometers are critically examined. Though the ideas have broader application, the discussion assumes the use of NaI(Tl) phosphors. The review of calibration sources includes tables of gamma-emitting radioisotopes employable for this purpose, with best energies, uncertainties, and other convenient data. The branching ratios among the naturally mixed x-ray lines (K-L vs K-M + K-N) are tabulated for useful radioisotope x-ray sources to enable use of a simple method given for determining the appropriate effective energy of the mixed source. The origins of spectrometer instability and nonlinearity are reviewed along with their relative importances, and defensive experiment designs and data analysis techniques are discussed. For finding the central position of the peak in a pulse-height distribution from gamma rays of a single energy, all the standard numerical and graphical methods are illustrated and compared, including full and partial nonlinear least-squares analyses. Finally, interpolation methods are detailed for determining from the available calibration information an unknown gamma-ray energy and its uncertainty. (auth)

344 (ORNL-TM-2013) A PDP-8 INTERFACE FOR A CHARGED-PARTICLE NUCLEAR PHYSICS EXPERIMENT. Burrus, W. R.; Madden, E.; McNew, C. O.; Peelle, R. W. (Oak Ridge National Lab., Tenn.). Oct. 4, 1967. Contract W-7405-eng-26. 35p. Dep. CFSTI.

An interface has been constructed to use a PDP-8 computer with a charged-particle detector system employing three solid-state detectors and flight-time analysis. Up to 48 bits from each randomly-occurring event are transferred through the data (break) channel to a hardware-selected buffer region in the core of a PDP-8 computer. Designed for use as a magnetic tape analyzer for the most complex cases, the system assumes that the 48 bits originate in flag bits set by fast logic and in (presently four) amplitude digitizers, all of which are assumed to contain information for the same event. The system includes some limited capability for controlling the course of the experiment, and provides for readout through the computer of a series of external fast counters. This report summarizes the design concepts, shows schematic flow diagrams, defines the computer instructions associated with the interface system, and gives simple model programs to illustrate methods of application. (auth)

345 (RT/FI-(66)36) CARATTERISTICHE DI UNO SPETTROMETRO PERLOW A PROTONI DI RINCULO. (Characteristics of a Perlow-Type Proton Recoil Spectrometer). Marseguerra, M.; Porceddu, C. M. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 1966. 13p. (In Italian). Dep.

The utilization of a proton-recoil Perlow-type neutron spectrometer for continuous spectral measurements is analyzed. The system and the pulse size distribution due to monoenergetic radiation are simulated by a Monte Carlo code and the results are in good agreement with the previous calibrations made at the Padua Van de Graaff accelerator. (auth)

346 (SC-TM-67-591) A 100-MHz COUNTING SYSTEM FOR AN ELECTRON SPECTROMETER. King, C. J. (Sandia Corp., Albuquerque, N. Mex.. Sept. 1967. Contract AT(29-1)-789. 49p. Dep. CFSTI.

An electron spectrometer system capable of counting electrons up to a rate of 10^8 pulses per second over an energy range of 1 to 30 kilovolts is described. Various parts of the system discussed and described in detail are: an electron analyzer; an electron multiplier tube; a wide-band pulse amplifier; level discriminators; a continuous calibration method; a high-voltage sawtooth generator; and a 100-MHz logic system. (auth)

347 DOPPLER EFFECT IN NEUTRON REFLECTION BY ROTATING CRYSTALS AND ITS UTILIZATION IN TIME FOCUSING OF REFLECTED NEUTRON BURSTS. Meister, H. (Gemeinsame Forschungszentrums, Ispra, Italy). Nukleonik, 10: 97-101(Sept. 1967). (In German).

A general treatment of the Doppler-effect in neutron reflection by rotating single crystals turns out that the space dependent shift of the reflected neutron velocity and of the reflection time can be expressed as linear functions of a coordinate which defines a rectangular coordinate system together with the bisector of the incoming and outgoing beam axes and the axis of rotation. With these results one comes to a condition for time focusing of the reflected neutrons with respect to a plane which is parallel to the axis of rotation and the bisector mentioned above. For this case $L = (1 + \cos^2 \Theta\ v(0)/(2\pi\nu \cos \Theta \cdot \sin \Theta)$ gives the right relation between the length L of the beam (from the axis of rotation to the plane of the focus), the mean neutron velocity $v(0)$, the Bragg-angle Θ and the frequency of the crystal rotation ν. By this means one easily can produce neutron bursts of a few 10^{-6} sec width even with large beam areas. (auth)

348 THE DEFOCUSING SPECTROMETER, AN INSTRUMENT OF HIGH RESOLUTION FOR NEUTRON SPECTROSCOPY IN THE MeV REGION. Meister, H. (Abteilung Neutronenphysik des Gemeinsamen Forschungszentrums, Ispra, Italy). Nukleonik, 10: 101-4(Sept. 1967). (In German).

The Defocusing Spectrometer represents a rotating crystal

device which is layed out in a way that neutrons, scattered elastically in the target, arrive focused in time at a plane, which contains the neutron detector. By inelastic processes the scattered beam is defocused. The smallest amount of the energy transfer to the neutron, which can be observed by this instrument, is independent of the dimensions of the rotating crystal and of its speed. Therefore it will generally be far below the value of the velocity spread of the reflected beam, caused by Doppler-effect. (auth)

349 GERMANIUM TOTAL ABSORPTION SPECTOMETER FOR 100-MeV PROTON SCATTERING. Horowitz, Y. S.; Sherman, N. K. (McGill Univ., Montreal). Can. J. Phys., 45: 3265-8(Oct. 1967).

A lithium-drifted germanium total absorption spectrometer has been constructed and used to achieve an energy resolution of 0.49 ± 0.05 MeV in proton-scattering experiments at 100 MeV. (auth)

350 SEPARATION OF PARTICLES AT INTERMEDIATE ENERGIES IN A GERMANIUM RANGE-TELESCOPE SPECTROMETER. Sherman, N. K.; Horowitz, Y. S. (McGill Univ., Montreal). Nucl. Instrum. Methods, 56: 106-8(Nov. 1967).

At intermediate energies, clean proton scattering spectra and heavy particle reaction spectra can be obtained simultaneously using a two-detector range telescope. The method is based on the large difference between the range of protons and the range of all heavier particles of comparable energy. Its application at 100 MeV using germanium detectors to study ^{12}C and ^{9}Be is described. (auth)

351 A HIGH-RESOLUTION Ge(Li) ANTI-COMPTON SPECTROMETER FOR RADIATIVE NEUTRON CAPTURE SPECTROSCOPY. Michaelis, W.; Kuepfer, H. (Kernforschungszentrum, Karlsruhe, Ger.). Nucl. Instrum. Methods, 56: 181-8(Nov. 1967).

A Ge(Li) anti-Compton spectrometer for the energy range up to 3 MeV is described which allows for the special conditions of (n,γ) spectroscopy and which gives improved performance compared to previously reported devices. The system consists of a planar 4.9 cm^3 Ge(Li)diode, a 50 cm dia. × 40 cm plastic scintillator, and a 4" dia. × 6" NaI(Tl) detector at scattering angle 0°. The anti-coincidence method together with a pulse-shape discrimination technique very effectively suppress the Compton background under the peaks. The energy resolution is 2.15 keV fwhm at 0.662 MeV. Typical capture spectra are presented to illustrate the performance of the system. (auth)

352 HIGH RESOLUTION PROTON SPECTROSCOPY WITH SEMICONDUCTOR DETECTORS. Andersson-Lindstroem, G. (Univ. of Pittsburgh). Nucl. Instrum. Methods, 56: 309-18 (Nov. 1967).

An extensive investigation was performed on the use of silicon surface barrier detectors for high resolution proton spectroscopy. The use of totally depleted detectors with application of considerable overbias, effective cooling of the detectors and suppression of the secondary electrons being generated in the target appears to be most important for getting good results. For 12-MeV protons a resolution of 11 keV fwhm is obtained, including an overall noise of 7 keV. The detector contribution is 7.1 keV, which gives a Fano-factor of 0.21. (auth)

353 EXTREMELY LOW-LEVEL GAMMA-RAY SPECTROMETER. Tanaka, S.; Sakamoto, K.; Takagi, J. (Tokyo Univ.). Nucl. Instrum. Methods, 56: 319-24(Nov. 1967).

An extremely low-level coincidence gamma-ray spectrometer has been established with heavy mass and anticoincidence shieldings. The main detector consists of a pair of 7.6 cm dia. × 7.6 cm NaI(Tl) crystals. The crystal has a 5 mm thick quartz window and is mounted in a 0.8 mm thick oxygen-free copper. The crystal is matched to a quartz-faced photomultiplier DuMont KM2559 and shielded laterally with a 1.1 cm thick purified mercury and a 1.5 cm thick oxygen-free copper. The detector system is set inside a 20 cm thick iron room, on which a plastic scintillator of 10 cm thick × 70 cm × 90 cm is placed as the anticoincidence guard. The whole assembly is built in an underground cell heavily shielded against major cosmic-ray components with a rock cover of at least 100 mwe. For a positron emitter, a 100 g source with specific activity of 1.6×10^{-3} dpm/g can be measured with a coefficient of variation of 1 in a total counting time of 2×10^4 min. (auth)

354 HIGH-SENSITIVITY NEUTRON-CAPTURE GAMMA-RAY FACILITY. Thomas, G. E.; Blatchley, D. E.; Bollinger, L. M. (Argonne National Lab., Ill.). Nucl. Instrum. Methods, 56: 325-37(Nov. 1967).

An exceptionally sensitive experimental system for the measurement of neutron-capture gamma rays is described and the characteristics of the system are examined critically. The results of measurements on the gamma-ray spectra from neutron capture in ^{6}Li, ^{10}B, ^{12}C, ^{13}C, and ^{14}N are reported. Some of these data are used to derive an accurate calibration of the efficiency of the Ge(Li) gamma-ray spectrometer used in the measurements. (auth)

355 CONSTRUCTION AND TESTING OF A MAGNETIC DOUBLE LENS BETA SPECTROMETER. Ostertag, Hermann (Univ., Cologne). Forschungsber. Landes Nordrhein-Westfalen., No. 1837, 1-41(1967). (In German).

The construction and testing of an Fe-free magnetic double lens β spectrometer with intermediate image focussing was described. The operational characteristics and properties of the instruments were studied. The spectrometer is designed for a maximum electron energy of 9 to 10 MeV. With the 75-kV direct current generator available, electrons up to 6.8 MeV can be focussed. Typical values for the relative half value width of a conversion line are 1 to 3% at appropriate light intensities of 3 to 8% of 4π for a source with 1 mm diameter. The contribution of the source diameter to the relative half value width is 0.35%/mm. A relationship between source diameter and suitable ring shield installation was given. (tr-auth)

356 IMPROVEMENT OF THE RESPONSE CAPABILITY OF A COMPTON SPECTROMETER WITH ENERGY ADDITIONS FOR ENERGIES $E_\gamma \leq 400$ keV BY USE OF AN ORGANIC SCATTERING SCINTILLATOR. Fischer, H.; Sturm, R. (Univ., Marburg, Ger.). Nucl. Instrum. Methods, 56: 346-50(Nov. 1967). (In German).

Using an organic scattering scintillator instead of a NaI(Tl)-crystal in a linear polarization sensitive Compton polarimeter the detection efficiency of the instrument is increased for γ-ray energies up to 400 keV, whereas the resolution decreases. In addition the total absorption peak has no longer gaussian shape. The improvement of efficiency and the loss of resolution was measured and compared with the results of some theoretical considerations. A rough estimate of the deviation of the total absorption peak from gaussian shape confirms the order of magnitude of the measured effect. (auth)

357 A SIMPLE SUMMING COMPTON Ge(Li) SPECTROMETER. Kantele, J.; Suominen, P. (Univ. of Helsinki). Nucl. Instrum. Methods, 56: 351-4(Nov. 1967).

A summing Compton spectrometer employing two Ge(Li) detectors is described. One of the crystals detects the Compton electron and the other the secondary quantum scattered through a mean angle of about 135°. For gamma spectrometry in the energy region above 0.3 MeV, the latter detector is set to accept energies between 150 and 350 keV, which results in a very large reduction of the Compton tails as compared to singles spectra. For a 1 MeV gamma, this arrangement reduces the Compton distribution typically by a factor of 40 to 50. Consequently, using high-resolution detectors, the method often allows the detection of weak gammas in the presence of 10^3 to 10^4 times more intense higher-energy lines. The intrinsic efficiency of the present simple spectrometer is of the order of 1% of that of a single crystal but can be noticeably increased by optimizing the geometry. (auth)

High Energy Physics Instrumentation

358 (ANL-7346) A PROPOSED SOLUTION TO THE "MATCH" PROBLEM. Pless, Vera (Argonne National Lab., Ill.). June 1967. Contract W-31-109-eng-38. 19p. Dep. CFSTI.

A method for matching three views of particle track photographs from a bubble chamber with a computer using a few parameters is described. The solution of the matching problem first uses a simple geometric criterion to determine which pair of tracks (from each of the three possible pairs of views) could represent the same track in space. From this, triples of tracks (one from each view) are constructed such that each pair of tracks from the triple could represent the same track in space. An estimator is then associated with each triple and eliminates those whose estimators are too large. The triples are then sorted into equivalence classes and the best triples are chosen depending in part on the estimator. (B.G.D.)

359 (JINR-P11-3512) STANDARTNAYA PROGRAMMA DLYA VYCHISLENIYA MAGNITNOGO POLYA V TOCHKAKH TREKA PO ZADANNOI TREKHMERNOI TABLITSE MAGNITNOGO POLYA V KAMERE. (Standard Program for Magnetic Field Calculation in the Track Points Using a Preset Three-Dimensional Table for the Chamber Magnetic Field). Moroz, V. I.; Mukhitova, O. V.; Tentyukova, G. N. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Computing Techniques and Automation). 1967. 19p. (In Russian). Dep.

This program is meant for calculation (by the linear interpolation method) of vectors of the magnetic field strength $H_x(x,y,z)$, $H_y(x,y,z)$, $H_z(x,y,z)$ for the set of space points in cases when the magnetic field is set in the points of three-dimensional orthogonal lattice. (auth)

360 (PPAD-629C) BUBBLE CHAMBER GEOMETRY MEASUREMENTS ON-LINE WITH A PDP-5 TO IBM 360-50 CONNECTION. Ball, J.; Bazin, M.; Benoit, J.; Davis, R. C. Jr. (Princeton-Pennsylvania Accelerator, Princeton, N. J.). Sept. 7, 1967. Contract AT(30-1)-2137. 8p. Dep. CFSTI.

Bubble chamber measurements have been carried out at the Princeton-Pennsylvania Accelerator on-line to a PDP-5 computer. The PDP-5 computer produces a tape which is directly readable by the THRESH geometry program for off-line analysis. The direct connection of the PDP-5 control computer to an IBM 360-50 in which the THRESH program resides is described. (B.G.D.)

361 (UCRL-17611) MP-II INFORMATION MANUAL. Ferguson, John M. (California Univ., Berkeley. Lawrence Radiation Lab.). June 7, 1967. Contract W-7405-eng-48. 48p. Dep. CFSTI.

The logic systems of the Measuring Projector Two (MP II) or "Franckenstein" for bubble chamber film analysis are described, and diagrams and some adjustment procedures are given. No attempt has been made to explain the electronic circuitry associated with the logic systems. (auth)

362 THERMODYNAMIC THEORY OF BUBBLE NUCLEATION INDUCED IN LIQUIDS BY HIGH-ENERGY PARTICLES. Sette, D. (Univ., Rome); Wanderlingh, F. J. Acoust. Soc. Amer., 41: 1074-82(Apr. 1967).

Creation of microbubbles in liquids, induced by high-energy ionizing particles, was examined from a thermodynamic point of view. The microbubbles originate from embryos statistically present in the liquid. Thermodynamic conditions for growth are created, and the energy required is furnished by the incoming particle. The case of bubble chambers was treated and the results obtained were in agreement with experimental data. Ultrasonic cavitation in water under normal conditions indicates the presence of microbubbles of 1 μ radius. An enormous amount of energy is required for the creation in pure water of such bubbles from a high-energy particle. This value is lowered by the presence of dissolved gases. It was shown that, if an ionizing particle passes through water containing dissolved gas, a threshold-energy value exists for the initiation of an exoenergetic process. When the particle energy is higher than the threshold, the particle may create a bubble of large size. On the basis of these conclusions, an explanation is given for experimental results of cavitation in water wherein it was observed that 10 to 14 MeV neutrons can create microbubbles of ~1 μ. The process suggested should ensure a statistical lifetime of the microbubbles in the liquid for a time sufficient to reach a condition at which the bubble may remain indefinitely stable: e.g., by adhering to a dust particle. (BBB)

363 EFFECT OF MULTIPLE SCATTERING ON MEASUREMENT OF TRACK MOMENTUM AND DIRECTION. Gluckstern, R. L. (Univ. of Massachusetts, Amherst). Nucl. Instrum. Methods, 56: 145-7(Nov. 1967).

The contributions of multiple scattering to the uncertainties in track momentum and direction are re-examined. In particular the kinematical restrictions for two body collisions are applied to small angle Rutherford scattering from a recoiling particle. The results are applied to tracks in hydrogen chambers, but a single track segment is no longer taken to include observable proton recoils in making estimates of the momentum and direction uncertainties. (auth)

364 DIGITALIZATION METHOD FOR ELECTRON DENSITIES FOR EXTENSIVE SHOWERS BY MEANS OF LARGE-AREA SCINTILLATION DETECTORS. APPLICATION TO THE LOCATION OF CORES. Catz, Ph.; Majerowicz, J. (CNRS, Verrieres le Buisson, France). Nucl. Instrum. Methods, 56: 69-73(Nov. 1967). (In French).

A new method is described to digitilize electron densities of extensive air showers. The density measurements are made by a group of 7 scintillation detectors each of 1 m^2 and covering an area of 1200 m^2. Each detector is associated with a logic circuit to digitilize the pulse heights. The immediate application of this method is the location of the core of extensive air showers ($E \geq 10^{15}$ eV). (auth)

365 THE USE OF GAS PROPORTIONAL COUNTERS TO DISTINGUISH PROTONS FROM PIONS IN THE COSMIC RADIATION AT ENERGIES OF NEAR OR GREATER THAN 100 GeV. Ramana Murthy, P. V.; Demeester, G. D. (Univ. of Michigan, Ann Arbor). Contract Nonr 1224(23). Nucl. Instrum. Methods, 56: 93-105(Nov. 1967).

Several possible methods to distinguish protons and pions in the cosmic radiation at energies of over 100 GeV are discussed. One of these methods based on multiple sampling of ionization losses in an array of gas proportional counters together with a measurement of energy in an ionization calorimeter or momentum in a magnet spectrograph is discussed in greater detail. Fluctuations in ionization losses (Landau fluctuations) make the method difficult but not impossible. Experimental results on Landau fluctuations with a variety of incident particles and energies are presented and it is shown that they are in better agreement with the theory of Blunck and Leisegang than with that of Landau. Artificial events in which the sampled ionization losses obeyed the Landau and Blunck and Leisegang distributions are generated on a computer by a Monte Carlo program. Based on an analysis of a sample of 20,000 such events by likelihood ratio method the attainable proton-pion separation in the cosmic radiation at 100 GeV energy is presented. (auth)

366 MAGNETIC CORE DIGITIZED SPARK CHAMBER FOR SPACE SCIENCE EXPERIMENTS. Ehrmann, C. H.; Fichtel, C. E.; Kniffen, D. A.; Ross, R. W. (Goddard Space Flight Center, Greenbelt, Md.). Nucl. Instrum. Methods, 56: 109-19 (Nov. 1967).

A magnetic core digitized spark chamber suitable for use on balloons and ultimately on satellites was developed. The assembled spark chamber consists of 32 active spark modules and forms the heart of a gamma-ray telescope. The individual modules consist of two orthogonal wire grids which form the spark chamber electrodes. Inclusion of a terminating resistor on each wire localizes the effect of the discharge, resulting in good multiple spark efficiency at low overvoltages. The lower voltages result in better spatial resolution with fewer wires sharing the spark. In the construction, considerable care was given to strength and long term operation under satellite conditions. The on-board data-handling system consists of a buffered memory readout, a housekeeping multiplexer, a tape recorder and a telemetry encoder and transmitter. (auth)

367 AN APPARATUS FOR MEASURING PHOTOPRODUCTION REACTIONS IN THE GeV RANGE WITH ON-LINE DATA ANALYSIS FACILITIES. Bar-Yam, Z. (Massachusetts Inst. of Tech., Cambridge); Elings, V.; Garelick, D.; Lewis, R.; Lobar, W.; Luckey, P. D.; Osborne, L.; Tazzari, S.; Uglum, J.; Fessel, R. Contract AT(30-1)-2098. Nucl. Instrum. Methods, 56: 1-22(Nov. 1967). (MIT-2098-336).

An apparatus is described consisting of a multichannel magnetic spectrometer with an on-line data analysis system. The spectrometer is used to analyze the momentum and emission angles of charged particles in the GeV range. The electronics system with associated computer can monitor the apparatus and give yields or cross-sections during the measurement. (auth)

368 OPERATION OF A TRACK SENSITIVE HYDROGEN TARGET INSIDE A NEON-HYDROGEN BUBBLE CHAMBER. Florent, R. (CERN, Geneva); Geles, C.; Harigel, G.; Leutz, H.; Schmeissner, F.; Tischhauser, I.; Horlitz, G.; Wolff, S.; Filthuth, H. Nucl. Instrum. Methods, 56: 160-4(Nov. 1967).

Two track sensitive hydrogen targets were developed. One of them was operated inside the 81 cm CERN bubble chamber filled with hydrogen. The other one was operated inside the 85 cm DESY bubble chamber which was filled with various neon-hydrogen mixtures. The results indicate the possibility of overlapping the thermodynamic ranges of sensitivity for hydrogen and for neon-hydrogen mixtures up to at least 14 mole % neon content. In this way bubble tracks can be obtained simultaneously in both media. (auth)

369 MAGNETOSTRICTIVE THIN-GAP WIRE SPARK CHAMBERS OF LARGE DIMENSIONS. Bradamante, F.; Sauli, F. (Univ., Trieste, Italy. Istituto Nazionale di Fisica Nucleare, Trieste, Italy). Nucl. Instrum. Methods, 56: 268-76(Nov. 1967).

The construction technique of thin-gap wire spark chambers of large dimensions has been improved. Two models have already been built and tested successfully in a beam at the CERN Proton Synchrotron; their external dimensions are 170×170 cm^2 and 210×210 cm^2, corresponding to a useful surface of 146×146 cm^2 and 186×186 cm^2, respectively. A conventional magnetostrictive read-out extracts the information from all the four wire planes which make up the two independent gaps of the chamber. The behavior of the chambers, as a function of the angle between the incident particles and the wire planes, has been investigated. Data are presented for the efficiency and the accuracy of location of particle tracks for different values of the incidence angle. It was found also that the accuracy of location is sensitive to the clearing field voltage. (auth)

370 EXACT TREATMENT OF SEARCH STATISTICS. Evans, D. A.; Barkas, W. H. (Univ. of California, Riverside). Contract AT(11-1)-34. Nucl. Instrum. Methods, 56: 289-92 (Nov. 1967). (UCR-34P107-42).

Exact formulas were found for the likelihood of any combinations of search statistics to result from successive scans of the same area. The formulas apply for similar events which are found with arbitrary efficiencies. One obtains a best estimate of the actual numbers of events present and simultaneously the interval corresponding to any particular level of confidence. (auth)

371 TOTAL ABSORPTION LEAD GLASS CHERENKOV COUNTER. Hemmi, Y.; Kikuchi, R.; Kobayashi, S.; Miyake, K.; Nakamura, T.; Okuno, H.; Yasumi, S.; Yoshimura, Y. (Kyoto Univ.). Nucl. Instrum. Methods, 56: 213-17(Nov. 1967).

A pair of total absorption lead glass Cherenkov counters was constructed to detect two γ-rays decaying from π^0-mesons. The experimental results of these counters with electron beams show that the pulse height is proportional to the electron energy E, and the energy resolution is 25% (fwhm) at 370 MeV and proportional to $E^{-1/2}$ at least up to 700 MeV. The detailed analysis of the energy resolution shows that the resolution can be improved up to 20% (fwhm) at 370 MeV and up to 15% (fwhm) at higher energies by increasing the efficiency of light collection. π^0-mesons from the reaction $\gamma + p \rightarrow \pi^0 + p$ were measured with the pair of counters. (auth)

372 ANTINEUTRON DETECTION SYSTEM. Glass, G.; Von Goeler, E.; Weinstein, Roy (Northeastern Univ., Boston). Nucl. Instrum. Methods, 56: 341-5(Nov. 1967).

An arrangement of scintillation counters was constructed to detect antineutrons in the momentum range 2 to 4 GeV/c. The system was used in a region of high background radiation. It detects pions produced when antineutrons annihilate. The efficiency of the system was measured for antineutrons, antiprotons and charged pions. (auth)

Radiation Dosimeters

Refer also to abstract 201.

373 (AD-648642) SILICON DIODE FAST-NEUTRON DOSIMETER. PHASE IV. DETERMINATION OF THE ENERGY DEPENDENCE OF THE DAMAGE CONSTANT. Speers, R. R. (Phylatron Corp., Columbus, Ohio). Jan. 1967. Contract DA-18-035-AMC-101(A). 37p. (NDL-TR-83-4). CFSTI.

Monoenergetic neutron irradiations of 50-mil-base-width silicon diodes were performed to determine the neutron energy dependence of the electrical parameters of the p-i-n diodes. The T (p,n)He3, D (d,n)He3 and T (d,n)He4 reactions and the Ohio State University 5.5-MeV Van de Graaff were used to produce neutrons having energies from 0.36 to 22.5 MeV. The diodes were fabricated from high lifetime, 600 ohm-cm, p-type material. The lifetime of the material in the base of the diode was typically 60 microsec. The energy dependence of the neutron bombardment degradation of two diode parameters was investigated. The parameters studied were damage coefficient for storage time and forward-voltage sensitivity at constant current. Neutron fluences in the range of 10^9 to 2×10^{10} power n/sq cm were employed for the irradiations. The results showed that the neutron energy dependence of the two parameters were identical and varied approximately as the square root of neutron energy for neutron energies from 0.36 to 4.77 MeV. For neutron energies above 4.77 MeV the experimental results do not follow a systematic trend. (auth) (TAB)

374 (NVO-162-30) ANOMALIES AND CURIOSITIES OF FILM DOSIMETRY. Brady, William J. (Reynolds Electrical and Engineering Co., Inc., Las Vegas, Nev.). Sept. 1967. Contract AT(29-2)-162. 12p. (CONF-670944-2). DTIE.

From 11th Annual Western Industrial Health Conference, San Francisco, Calif.

Anomalies and curiosities of multifilter film dosimeters used for personnel monitoring are discussed. Determination of dose from film densities, exposure geometry, and emulsion damage are included topics. (W.H.K.)

375 (NYO-3510-3) BIOLOGICAL AND CLINICAL DOSIMETRY. Annual Progress Report, July 1, 1966-June 1, 1967. Laughlin, John S. (Sloan-Kettering Inst. for Cancer Research, New York). July 6, 1967. Contract AT(30-1)-3510. 17p. Dep. CFSTI.

An extensive series of measurements comparing cavity ionization with calorimetrically determined absorbed dose as a function of depth in C irradiated by 20 MeV electron were completed. Theoretically computed values of the mean stopping power ratio between C and air including the polarization effect were in good agreement with those measured. The $G(Fe^{+++})$ of the Fricke (ferrous sulfate) dosimeter was determined at several depths for 20 MeV electrons and was found to be constant. The RBE of 20 MeV electrons was investigated at depths of 1.0 and 8.7 gm/cm^2 (H_2O equivalent) with HeLa cells. No significant difference in cell survival was found. Utilizing an intensity calorimeter, the dose rate dependence of the CaF_2:Mn dosimeter was investigated up to 5×10^{12} rads/sec. Dose control by use of beam limiting apertures was found to be satisfactory and depth dose data were obtained. Further experimental investigations were made of the energy dependence of LiF and CaF_2:Mn thermoluminescent dosimeters for fast electrons and ^{60}Co γ rays with the carbon calorimeter. No significant energy dependence was found for Teflon matrixed phosphors. A preliminary survey of the performance of semiconductor detectors for high energy radiation dosimetry was completed and their suitability for dose distribution determination demonstrated. An active program of consultation to assist the National Bureau of Standards in establishing its electron beam calibration service is in progress. A miniature diode was constructed with a wrap-around junction geometry that provided approximate azimuthal symmetry around an axis through the diode parallel to the junction. An increase in sensitivity was also associated with this geometry that was aimed at the measurement of absorbed dose from ^{60}Co γ rays in tissue equivalent material. Three separate square arrays of lithium drifted diodes were constructed in two distinct configurations and tested for eventual use in position indicating nuclear particle counting systems, e.g., a low energy gamma camera. The diode elements of each array had a common compensated region. The most promising of the three units fabricated was a 1.5 centimeter square matrix of 36 diodes. The most difficult single problem connected with the operation of such arrays, that of obtaining a sufficiently high interdiode resistance, appeared to be solved. The aim of this work was to demonstrate that a diode array of this configuration was suitable for use as the unit in counting systems of larger arrays of diodes. Approximate efficiency curves for gamma counting with silicon and germanium diodes were calculated and are presented, based on primary photoelectric interactions. A 150 micron diode window was assumed. (auth)

376 (USNRDL-TR-67-67) THE RELATIONSHIP BETWEEN THE RADIOBIOLOGICAL EFFECTS TABLE AND TACTICAL MILITARY RADIATION MEASUREMENT SYSTEM DESIGN. Sinclair, Kenneth F. (Naval Radiological Defense Lab., San Francisco, Calif.). May 29, 1967. 36p. CFSTI.

The tactical radiation measurement systems are used in the military primarily for the acquisition of radiation data for entry to the Radiobiological Effects Table (RET). The table provides the bridge needed to translate a radiation measurement to information regarding the present and probable future (short term) operational effectiveness of a military group. At present, the RET is stated in terms of exposure in roentgens or absorbed dose in rads (air); and the radiac instruments are calibrated in either of these units in a free-air point source geometry. This results in large errors under certain field conditions. In the fallout gamma radiation field from nuclear weapons, ratemeters and dosimeters are estimated to understate the true dose or dose rate by 50 percent. In the initial gamma radiation environment (ignoring rate effects), dosimeters understate the dose about 20 percent facing the detonation and about 55 percent facing away from the detonation. This difference is a result of the fact that the dosimeter is presently worn on one side of the body; and initial radiation, at ranges where the dose is important, is essentially unilateral. The situation for initial radiation neutron dosimeters now under development is much worse. Since available information regarding the acute biological effectiveness of neutrons as a function of energy has not been taken into account in the design, it appears that the dose will be overstated by a factor of about 6 facing the detonation and about 2 facing away. The errors in fallout and initial radiation fields can be greatly minimized by correlating the effects table with midline dose and retaining the present calibration method for the devices. For neutrons, it is essential that the biological effectiveness vs. energy consideration be taken into account. Otherwise, no significant improvement can be made. (auth)

377 ALL-STATE FILM-DOSIMETRY SERVICE IN CSSR. PART II. CALCULATION OF GAMMA-, BETA, AND X-RAY DOSES. Trousil, Jaroslav; Bucina, Ivan (Inst. for Research, Production, and Application of Radioisotopes, Prague). Jad. Energ., 13: 370-5(Oct. 1967). (In Czech).

The second part deals with the calculation of doses of pure

gamma, beta and x rays and their mixtures. For calculation of gamma and x-ray dose simple methods were suggested, based on the one quality ratio and used besides complete filtration analyses. The process of dose evaluation is selected according to the magnitude of apparent dose ratio under the lead filter and open window. For calculation the beta-ray doses and mixtures with gamma and x rays, two methods were suggested. The more accurate dose calculation needs a new holder with two filters from plastic material and makes it possible to distinguish between beta and soft x rays up to 25 keV. With the holder, used at present, the calculation is less accurate and distinguishing of x rays is possible only over 45 keV. The way of calibration of energy dependence of dosimeter films is described in the conclusion of this part. (auth)

378 FILM DOSIMETRY: A THING OF THE PAST? Becker, Klaus (Nuclear Research Center, Juelich, Ger.). Euratom Bull., 6: 78-83(Sept. 1967).

Although film dosimeters are now being used on a larger scale than ever before, their days are very probably numbered, since no basic improvements are to be expected. Even now film dosimetry at advanced nuclear research centres is beginning to be ousted by superior solid-state dosimetric techniques, which have been thoroughly studied over the last few years and, in some cases, substantially improved. However, the increased accuracy of the latest dosimeters should not blind one to the fact that personnel dosimetry entails numerous basic possibilities of error. (auth)

379 PENTON USED AS A DOSIMETER FOR 4 TO 15 keV X-RAYS. Mallon, Barbara J. (Univ. of California, Livermore). Contract W-7405-eng-48. J. Polym. Sci., Part B, 5: 977-81 (Oct. 1967). (UCRL-70566).

The use of Penton, poly-3,3-(bischloromethyl)-oxetane, for dosimetry of 4- to 15-keV x rays is discussed. The energy absorbed is found to be directly related to the heat of fusion, melting point, and optical density of Penton, due to radiation damage. Graphs showing these relations are included. (W.H.K.)

380 CALIBRATION OF THIMBLE CHAMBERS IN A 34 MV ROENTGEN BEAM. Hettinger, G.; Pettersson, C.; Svensson, H. (Univ. of Umea, Sweden). Acta Radiol., Ther., Phys., Biol., 6: 214-18(June 1967).

Ionization chambers were calibrated against ferrous sulphate dosimeters in a water phantom exposed to 30 MV roentgen radiation, and the values obtained were practically the same at all depths. The ratio between the dose calibration for 34 MV roentgen rays and the exposure factor for Co-60 gamma radiation was the same with all the four chambers used. The ionization was measured with two different thimble chambers, a Siemens Sonderfingerhutkammer with a radius of 3 mm, and a Siemes Fingerhutkammer with a radius of 8 mm, a Philips Intercavity chamber, and a Baldwin Farmer (Substandard M2). The good agreement between the values obtained indicates that the dose calibration factors for these two chambers will remain the same at all depths. This, of course, will be true only if the effective measurement point of the chamber is selected as mentioned above. Measurements off the beam axis resulted in equal calibration factors. Results similar to those represented in our diagrams were obtained for other thimble chambers as well. (auth) (SWED)

381 AUTOMATIC ISODENSITY RECORDER FOR PHOTOGRAPHIC DOSIMETRY. Pettersson, C. (Univ. of Umea, Sweden). Acta Radiol., Ther., Phys., Biol., 6: 225-32(June 1967).

An automatic isodensity recorder giving optical density readings in the form of continuous curves is described. It was designed chiefly for use in the evaluation of dosimetric films in the clinic and for regular control of the radiation fields of accelerators. (auth)

382 IONIZING RADIATION DOSIMETER CASING. Schellekens, J. F. F. C. C. (to Manufacture Belge de Lampes et de Material Electronique). Canadian Patent 760,042. May 30, 1967. Priority date Sept. 10, 1962, Belgium.

The dosimeter casing is made of aluminum or other material which absorbs x-rays only slightly but is impervious to visible light. For use, the dosimeter is hermetically sealed in the casing by two lugs and other related devices. A special tool is described which is used for sealing and for replacing the dosimeter with another in the same casing after use. (F.S.A.)

383 EXPERIENCE WITH A NEW THERMOLUMINESCENCE METHOD FOR FINGER AND HAND DOSIMETRY EMPLOYING LITHIUM FLUORIDE-TEFLON DOSIMETERS. Bjarngard, Bengt E.; Jones, Douglas (Controls for Radiation, Inc., Cambridge, Mass.). 10p. (CONF-660920-17). DTIE.

From 1st International Congress of the International Radiation Protection Association, Rome.

Developments in the use of lithium fluoride-teflon thermoluminescent dosimeters for finger and hand dosimetry are discussed. The technique employed and advantages and disadvantages encountered are presented. (W.H.K.)

Radiometric Instruments

Refer also to abstracts 260 and 261.

384 (ORNL-IIC-10(Vol.2), pp 870-902) BINARY SYSTEMS ANALYSIS WITH AN ^{125}I RADIATION SCATTER GAUGE. Berry, P. F. (Atomic Energy of Canada Ltd., Ottawa (Ontario). Commercial Products Div.).

The technique of low-energy electromagnetic radiation scattering employing a cylindrical co-axial geometrical arrangement of source and detector has been shown to provide a highly sensitive method of analysis which is particularly applicable to binary systems. The high sensitivity of the method has been demonstrated on water-ether and meat-fat systems and for the latter analysis the instrument described is capable of determining meat-fat ratios to ±1% (absolute) in ground meat, or in-carcass, with negligible effect of sample compaction. Sample density effects are not at present fully understood, but preliminary results indicate that the effects are small enough to make possible analysis of granular media such as coal/ash with the advantages, over methods described to date, of higher sensitivity and lower particle size effects. In addition to application to the systems described, the method may also be considered for analyses of mineral content of water, rocks and soil. (auth)

385 (Y-DA-1583) TANGENTIAL RADIOGRAPHY FOR DIMENSION MEASUREMENTS. Cofield, R. E.; Snow, S. G. (Union Carbide Corp., Oak Ridge, Tenn. Y-12 Plant). Sept. 29, 1967. Contract W-7405-eng-26. 51p. (CONF-671002-3). Dep. CFSTI.

From 27th National Fall Conference of the Society for Nondestructive Testing, Cleveland, Ohio.

Tangential radiography is a useful tool for measuring the thickness of walls and adjacent layers; particularly those having spherical, cylindrical, and related geometries; when the surfaces are not accessible for conventional measurements. The radiation opacity contrasts encountered are evaluated mathematically for a range of practical dimensions and the interacting effects of layer thickness, radius of curvature, and absorption coefficient for the penetrating radiation used are described. Practical tangential radiography techniques for measuring wall thickness and individual layer thicknesses in multilayered structures are reported. Masking, filtration and compensation methods which improve the imaging and measurement of thickness are described. Experiments in the use of scanning microdensitometry for measuring dimensions for tangential radiographic images have been performed and are discussed. (auth)

386 NUCLEAR MEASUREMENT OF CARBON IN BULK MATERIALS. Stewart, Robert F. (Bureau of Mines, Morgantown, W. Va.). ISA (Instrum. Soc. Amer.) Trans., 6: 200-8 (July 1967).

A method is described for continuous measurement of carbon in granular materials by counting the 4.43-meV gamma rays produced from carbon atoms by the inelastic scatter of neutrons. The carbon content in iron-ore sinter mix and in fly ash containing 2 to 16% carbon was determined within 0.5% carbon, and repeated tests on one sample of sinter mix showed a precision of 0.2% carbon. Tests on coal samples as large as 4000 lb show the possibility of adapting the method to continuous process control of materials at high-tonnage flow rates. Considerations of nuclear design, instrumentation, and materials handling are discussed for commercial use of a continuous carbon meter for process control. (auth)

387 DENSITY AND TEMPERATURE IN WIND TUNNELS USING ELECTRON BEAMS. Cunningham, J. W.; Fisher, C. H.; Price, L. L. (Arnold Air Force Station, Tenn.). IEEE (Inst. Elec. Electron. Eng.), Trans. Aerosp. Electron. Syst., AES-3: 269-84(Mar. 1967).

A method of measurement was described wherein the density of a gas is inferred from the rate at which particles are scattered out of a beam of β radiation. Also described were tests of the method using γ rays and preliminary work using 50-keV electrons. Theoretical limitations on the method using electrons are discussed, and results of tests in a low-density wind tunnel using electron scattering are reported. An electron beam was also used to measure rotational temperature in this wind tunnel, results of which are presented. Measurements with ^{137}Cs γ radiation were made in the flame of a propane torch, which agreed with conventional aerodynamic measurements. The counting rates observed agreed with the assumed scattering mechanism

(Compton scattering). Since long-measuring times were necessary, 50-keV electrons were introduced as the probing particles. Since the electrons carry a charge, it was possible to focus them in the desired direction, so that a smaller, more intense beam could be obtained. The 50-keV electrons were applied in a wind tunnel using air as a test gas. Test section temperature and density were 150°K and 6×10^{-8} g/cm³. Accuracies better than 1.0% were attainable, together with excellent spatial and temporal resolution. (BBB)

388 METHOD AND APPARATUS FOR PRODUCING X-RAYS OF PARTICULAR WAVE LENGTHS AND APPLICATIONS THEREFOR. Watt, J. S. (to Australian Atomic Energy Commission). Canadian Patent 758,195. May 2, 1967.

Methods are described for producing x-rays of certain wave lengths using isotopes Gd-153, Eu-155, Sm-145, I-125, Tm-170, Am-241 as primary γ ray sources. The proper combination of source and target material gives the desired wave length. Secondary or tertiary emissions are controlled by various shields and filters. The x rays are intended for measurements of coating thickness or alloy constituent analysis. (F.S.A.)

Miscellaneous Instruments and Components

Refer also to abstracts 1121 and 1346.

389 (AD-648216) STUDY OF A PULSED UNDERWATER SOUND PROJECTOR. Semiannual Status Report No. 2. Guman, W. J.; McIlroy, W. (Fairchild Hiller Corp., Farmingdale, N. Y. Republic Aviation Div.). Dec. 1, 1965. Contract Nonr-4741(00). 47p. (FHR-2229-2; PCD-TR-65-27). CFSTI.

The report presents experimental results of the inverse pinch-type discharge, and an analytical scheme for spectrum analyzing pressure traces and some of the results that have been obtained. In particular it is intended to try to gain further insight into the role that magnetohydrodynamic effects play in the pressure waveform and spectral distribution of acoustic energy. The existence of either of two types of electrical discharges is examined in more detail and it is found that a definite correlation exists between the current waveform, the light emitted by the plasma and the shape of the acoustic signal. (auth)

390 (BNWL-SA-1314) MICROWAVE TECHNIQUES FOR REACTOR INSTRUMENTATION. Billeter, T. R.; Brown, D. P. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Oct. 19, 1967. Contract AT(45-1)-1830. 20p. (CONF-671102-27). Dep. CFSTI.

From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill.

Microwave techniques and equipment for measuring various physical properties in nuclear reactors, especially those reactors expected to operate at radiation levels and temperatures which obviate the use of conventional measurement techniques, are investigated. Techniques are described to minimize problems of insulation degradation and spurious noise interference. A thermal neutron flux monitor and temperature sensor system are described. (W.H.K.)

391 (KR-118) THEORETICAL AND EXPERIMENTAL INVESTIGATION OF IMPEDANCE VOID METERS. Olsen, Hans Otto (Institutt for Atomenergi, Kjeller (Norway)). Aug. 1967. 157p. Dep. CFSTI.

Thesis. Submitted to Univ. of Oslo, Norway.

A survey of literature on theories on the dielectric constant, especially the electric conductivity of two-phase media, is given. Impedance void meters of different types and number of electrodes are calibrated against a quick-closing valves system in an air–water loop of channel diameter 26 mm. The influence of several parameters on the void meter readings is investigated. The experimental results show dependency of flow rate, electrode geometry and flow regime. From experiments and theoretical considerations two alternative void meter geometries are described. (auth)

392 (TID-24094) TRANSFORMER DESIGN FOR FAST PULSE CIRCUITS. Scientific Report No. 20. Crouse, J. C.; Pierce, J. F. (Tennessee Univ., Knoxville. Dept. of Electrical Engineering). Nov. 1, 1965. Contract W-7405-eng-26; Subcontract 2160. 42p. Dep. CFSTI.

For Oak Ridge National Lab., Tenn.

The design requirements for pulse transformers having rise times as short as one nanosecond are investigated. Using operational methods and equivalent circuits, a theoretical analysis of a high-speed pulse transformer was performed. The results of the theoretical analysis were applied to the design of nanosecond pulse transformers. The value of primary inductance necessary for the required low-frequency response may be calculated from the results of the theoretical analysis. For a given core material, core size, and number of primary turns, an approximate value of primary inductance may be calculated from the specifications of the core material. The actual value of inductance is generally within 20% of the calculated value. The relationship between the core size, core material, and number of primary turns which optimizes the rise-time response of the transformer must be determined by trial and error. An example illustrating the method of designing nanosecond pulse transformers is included. Pulse transformers having rise times between 0.2 and 2.1 nanoseconds were constructed. The input pulse widths at which the output voltages of these transformers decayed to 36.8% of their 100% value ranged from 59 to 1,950 nanoseconds. (auth)

393 (UCID-15220) METHODS OF HIGH IMPULSE CURRENT MEASUREMENTS: EMPHASIS ON RESISTIVE SHUNTS. Thomas, Robert J. (California Univ., Livermore. Lawrence Radiation Lab.). Mar. 9, 1967. Contract W-7405-eng-48. 19p. Dep. CFSTI.

The measurement of impulse currents of the order of hundreds, thousands, or millions of amperes is usually accomplished by one of three methods: the magnetic probe method, the current transformer method, and the pure resistive shunt method. The basic principles and proper application of the pure resistive shunt method are discussed. A review and comparison of all three methods in order to develop criteria for selection of the most appropriate method for particular applications, is presented. (auth)

394 (UCID-15222) CALIBRATING MUTUAL INDUCTANCE PROBES. Faraudo, B. D. (California Univ., Livermore. Lawrence Radiation Lab.). Nov. 29, 1966. Contract W-7405-eng-48. 8p. Dep. CFSTI.

Pickup loops used for measuring currents are frequently calibrated by using a ringing RLC circuit using the assumption that the error is small when lightly damped. A technique is described which shows when the error was significant and allows accurate calibrations even in a more heavily damped case. (B.G.D.)

395 (UCRL-17691) VERSATILE APPARATUS FOR MEASURING TOTAL AND DIFFERENTIAL CROSS SECTIONS FOR ION–NEUTRAL INTERACTIONS. Gentry, W. R. (California Univ., Berkeley. Lawrence Radiation Lab.). July 1967. Contract W-7405-eng-48. 106p. Dep. CFSTI.

A beam apparatus for studying the dynamics of ion–neutral interactions in the primary ion energy range 5 to 500 eV is described. The criteria considered in the design of the apparatus are discussed, and a description of the individual components and their interrelation is given. Discussion of the experimental operation and data analysis is included. The two modes of operation by which data were previously obtained are used to illustrate the capabilities of the equipment. (J.F.P.)

396 THE TESLA GAS FLOW COUNTERS. Gilar, Oldrich; Pavlicek, Zdenek (Univ., Prague). Jad. Energ., 13: 387-90 (Oct. 1967). (In Czech).

A circuit diagram is presented. The operation and control are described. (R.V.J.)

397 AUTOMATIC DATA TELEMETERING SYSTEM FOR METEOROLOGICAL AND RADIATION DATA. Sachdev, R. N.; Nadgir, S. B.; Rajan, K. K. (Bhabha Atomic Research Centre, Bombay). J. Appl. Meteorol., 6: 969-72(Oct. 1967).

A system for radio transmission of meteorological and radiation data from remote stations to a central station is described. Four channels, using time multiplexing, are incorporated in this system to record information on wind speed, wind direction, beta–gamma activity, and gamma activity. (W.H.K.)

398 DESCRIPTION OF A TRANSISTORIZED TIME-TO-AMPLITUDE CONVERTER. Bouillard, J. G.; Motta do Amaral, L. C. (Pontificia Univ. Catolica, Rio de Janeiro). An. Acad. Brasil. Cienc., 39: 59-64(Mar. 1967). (In Spanish).

The time-to-amplitude converter described is used for the measurement of very short times or the order of nanoseconds separating two very close successive events. Several examples of possible uses for the converter are given, the principle of operation, and the practical realization of what was done with it. Following this a critical study and several suggestions are given which can considerably improve the performance of the apparatus. Lastly are presented methods which permit the standardization and determination of the actual characteristics of this apparatus. (J.F.P.)

399 EXPERIMENTS WITH QUADRUPOLE LENSES IN A SCANNING MICROSCOPE. Crewe, A. V. (Argonne National

Lab., Ill. Univ. of Chicago); Eggenberger, D. N.; Welter, L. M.; Wall, J. J. Appl. Phys., 38: 4257-66(Oct. 1967).

A scanning electron microscope using a quadrupole doublet as the focusing lens is described. The optical properties of an unsymmetrical, "pseudostigmatic" (unequal magnifications in perpendicular planes) doublet are summarized, and rotational misalignment of the elements is discussed. Experimental studies were made to determine the dependence of the final image size on lens aberrations and construction defects. A computer was used to fit the experimental data to a generalized spot size equation. Separate experiments were made on both magnetic and electrostatic doublets, and the smallest experimental image size (which appears to be limited by astigmatism) was 150 by 450 Å using either quadrupole system. Experimental results agree with recent computer predictions for these doublets, and further calculations indicate that the use of quadrupoles and octupoles in a scanning microscope may be advantageous. (auth)

400 NEW SHUTDOWN AMPLIFIER (s.d.a.) FOR NUCLEAR REACTOR. PART I. Morris, I. G. Electron. Eng., 39: 485-9(Aug. 1967).

Since its original application as a neutron-flux protective element over the upper decades of power and for continuous monitoring during full-power operation, the shutdown amplifier (s.d.a.), as employed in UK civil reactors, has remained almost as it was originally designed by the UKAEA, except for minor modifications which have been included to suit particular station requirements. Basically the commercial equivalents have retained the original circuit form, this consisting of a d.c. amplifier operating through a mechanical chopper of dubious reliability and relatively short life. The low-current input signal, converted into a suitable voltage is compared with a reference, amplified in various valve stages, followed by a phase-sensitive output stage; meter indication and appropriate alarm and trip stages are provided. Reactor-protection instrumentation has, however, followed the general trend of transistorized equipment. The first item in this field to be made solid state was the temperature-trip amplifier; this has been followed, more recently, by neutron-flux instrumentation. The basic design of one of a family of newly developed transistorized neutron-flux protection instruments, namely the shutdown amplifier which is to be installed as part of the Wylfa Nuclear Power Station equipment, is discussed. (auth)

401 A SMALL 180° FAST SCANNING MASS SPECTROMETER. Jefferies, D. K. (United Kingdom Atomic Energy Authority, Abingdon, Eng.). J. Sci. Instrum., 44: 587-92(Aug. 1967).

A fast scanning mass spectrometer has been developed for monitoring fast changes in residual gas compositions. A full mass scan from 2 to 100 a.m.u. in 100 msec has been achieved. A 180° magnetic deflection mass spectrometer was used to obtain a larger mass range, using electrostatic scanning, than is possible in a 60° or 90° sector magnet without serious mass discrimination. The time constant of the detector circuit was reduced by incorporating an Allen type electron multiplier, using a form of Wien filter to extract the ion beam from the magnetic field into a field-free region. At the fastest scanning speeds the sensitivity of the mass spectrometer is limited by statistical fluctuations in the number of ions arriving at the first dynode of the multiplier. A scanning speed of approximately 1 a.m.u. $msec^{-1}$ and a source sensitivity of 0.1 mA $torr^{-1}$ produces a statistical fluctuation of about ±3% at a partial pressure of 10 ntorr and ±10% at a partial pressure of 1 ntorr. (auth)

402 DIGITAL RADIOISOTOPIC SCAN RECORDER. Kawin, B. (Veterans Administration Hospital, Washington, D. C.); Whiting, R. Med. Biol. Eng., 5: 371-7(July 1967).

To better quantize and preserve the data output available from rectilinear radioisotope scanning, a method of digital recording was introduced. To accomplish this, equipment and procedures were developed that provide for 3 major general requirements of a digital recording rectilinear scanning system. Its features conform to the following needs: (1) adequate data-recording capacity, (2) compliance with format of scanning procedure, and (3) economic feasibility. To incorporate these requirements into a single system a prototype device, the Recorder Control Unit (RCU) was developed. This instrument collects and arranges the digital pulse output of the detector in an appropriate recorded pattern, producing a punched paper tape record suitable for subsequent data processing. RCU inputs and functions are shown in a block diagram. Basically, input to the RCU consists of scan field limit signals, data pulses from the measurement scaler, and signals that orientate the scan field to the organ area scanned. The controls of the RCU consist of an attached typewriter, time selector, scan data recording function, a test function, and a provision for telephone transmission of the scan data, if desired. All of the measurement inputs and data control features are recorded in a standard Friden 8-level alphanumeric code on 1-in. wide punched paper tape. (BBB)

403 DIRECT COLLECTION OF RETARDED ION BEAMS IN AN ELECTROMAGNETIC ISOTOPE SEPARATOR. Fontell, A.; Arminea, E. (Univ. of Helsinki). Ann. Acad. Sci. Fenn., Ser. A VI, No. 2, 1-14(1967).

A retardation lens system was constructed for an electromagnetic isotope separator and employed for retarding an ion beam of the order of 10 μA to an energy of some tens of electron volts. The collection efficiency of Al, K and Fe ions on the surface of graphite blocks was studied as a function of ion beam energy in the direct collection method. The quantity collected was measured by the elastic scattering of protons accelerated by means of a Van de Graaff accelerator. (auth)

404 MEASUREMENT OF γ EMITTERS WITH A SINGLE-CHANNEL ANALYZER AT PLATEAU LEVEL. Potschwadek, B. Atompraxis, 13: 353-4(Aug. 1967). (In German).

With high pulse rates or relatively unstable electronics, the selected channel width of a single-channel analyzer can be so broad that the result is practically a plateau. This is attained when the channel width is equal to three times the half-width of the particular counter for the nuclide being measured. (auth)

405 AUTOMATIC FOLDING IN MOESSBAUER EXPERIMENTS THROUGH FORWARD–BACKWARD OPERATION OF THE MULTICHANNEL ANALYZER. Nadav, E.; Palmai, M. (Hebrew Univ., Jerusalem). Nucl. Instrum. Methods, 56: 165-9(Nov. 1967).

Modifications of binary and BCD Address Registers for "forward-backward" scaling are described. Synchronisation methods in high resolution Mössbauer experiments are discussed. A complete circuit including compensation of inherent system delay for automatic "folding" is presented. (auth)

406 RANDOM SIGNAL QUANTIZATION AND ITS EFFECTS IN NUCLEAR PHYSICS MEASUREMENTS. De Lotto, I. (CNR, Bologna. Istituto di Elettronica, Bologna); Osnaghi, S. Nucl. Instrum. Methods, 56: 157-9(Nov. 1967).

Equations for the effects of the quantization on the mean value and the variance of a random variable are presented for some usual channel profiles in nuclear instrumentation. (auth)

407 HYBRID COMPUTER FOR ACTIVATION AND DECAY CALCULATIONS. Loria, G. (Comision Nacional de Energia Nuclear, Mexico City, Mex.). Nucl. Instrum. Methods, 56: 77-9 (Nov. 1967).

A hybrid computer was designed and built for the easy calculation of activation and decay of a radioisotope subject to the intermittent neutron flux of the Triga Mark III reactor. Given a certain semifixed sequence of operation of the reactor, this computer shows the time required to achieve a certain amount of saturation, or the amount of saturation obtained after a given number of days of irradiation. It is also possible to know the activity of the daughter isotope formed by the decay of the previously considered mother. (auth)

408 FAST ZERO-CROSSING DISCRIMINATOR FOR TIME PICKOFF WITH PULSED BEAMS. Gedcke, D. A.; McDonald, W. J. (Univ. of Alberta, Edmonton). Nucl. Instrum. Methods, 56: 148-50(Nov. 1967).

A fast zero-crossing discriminator has been designed for use as a pulsed-beam time pickoff in time-of-flight experiments. Use of the zero-crossing technique minimizes the effect of fluctuating beam conditions on the time information. The walk was measured to be within ±65 psec from 100 mV to 3.5 V input pulse height. The threshold is variable from 100 to 500 mV. Observed jitter in the pulsed beam timing is ≤40 psec. Operation is independent of pulse shape making this discriminator useful for other applications. (auth)

409 MULTIPLE SLOW COINCIDENCE CIRCUIT WITH PULSE SHAPING BY SATURATED TRANSISTORS. Moszynski, M. (Inst. of Nuclear Research, Swierk, Poland). Nucl. Instrum. Methods, 56: 141-4(Nov. 1967).

The stretching of pulses by a high-saturated transistor is considered. This phenomenon is applied for the pulse shaping in a slow coincidence circuit. An instrument with four coincidence channels and one anticoincidence channel is described. (auth)

410 100 Mc/s GATED CLOCK OSCILLATOR. Turko, B. (Inst. Rudjer Boskovic, Zagreb). Nucl. Instrum. Methods, 56: 261-7(Nov. 1967).

A simple gated clock oscillator is analyzed, where gating pulse rise and fall times are comparable to the period of oscillations. Resonator response to ramp forcing function assuming a linear

damping device is found and curves for calculating the amplitude and initial phase angle of the oscillation are shown. Condition for compensation of resonator losses is found and interval of damping of oscillations is analyzed. Also the circuit diagram and the waveforms at the 100 Mc/s clock frequency are shown. (auth)

411 ACCURATE MEASUREMENTS OF COAXIAL CABLE DELAY LINES. Kiesler, R.; Righini, B. (CERN, Geneva). Nucl. Instrum. Methods, 56: 357-8(Nov. 1967).

A reliable method to measure coaxial cable delay lines is described. The experimental setup and the result of the measurements are described and discussed. (auth)

412 MODIFIED MAGNETIC MOMENTUM SLIT INCLUDING A PAIR OF C-TYPE MAGNETS. Brechna, Habib; Hedin, Bengt (to U. S. Atomic Energy Commission). U. S. Patent 3,355,586. Nov. 28, 1967.

A momentum analyzing slit including a pair of C-type magnets having cores that each develop a sharply defined magnetic field between respective poles across a main gap along opposite sides of a magnetically neutral slit is described. Each pole includes a coil, a central core, and an outer piece that encloses the coil and functions as a slit side. The outer piece is magnetically connected with the central core at the outer end of the coil. There is a small gap, substantially smaller than the main gap, between the central core and the outer piece across the face of each pole. Charged particles centrally directed through the slit are not affected by the sharply defined magnetic fields. Particles that are not centrally directed enter one of the magnetic fields to be forced along a curved path for momentum analysis or controlled dumping. (AEC)

Radiation Effects on Instruments and Instrument Components

413 (AD-648236) RADIATION STUDY ON MOS STRUCTURES. Snow, E. H.; Grove, A. S.; Fitzgerald, D. J. (Fairchild Semiconductor, Mountain View, Calif.). Jan. 1967. Contract AF19(628)-5747. 74p. (AFCRL-67-0062). CFSTI.

The report examines in detail the effects of electron, x-ray, and ultraviolet radiation on oxidized silicon surfaces and planar devices. Two permanent surface effects of ionizing radiation are distinguished: the build-up of a positive space-charge within the oxide and the creation of fast surface states at the oxide-silicon interface resulting in increased surface recombination velocity. The dependence of these effects on dose and dose rate, on bias applied during irradiation, and on structural parameters is discussed and a theory involving hole trapping is presented which accounts for the observed features of the space-charge build-up. Radiation-induced changes in the characteristics of MOS field-effect transistors, p-n junction diodes and pnp and npn transistors are reported and examined in terms of the above two effects. It is shown that the charge build-up causes shifts in the operating point of MOS transistors, catastrophic increases in the reverse current of p-n junctions, and large variation in their breakdown voltage. The increase in fast surface state density is responsible for the lowering of the transconductance of MOS transistors and, in combination with the space-charge build-up, for the degradation of the current gain in bipolar transistors. (auth) (TAB)

414 (AD-648380) EFFECTS OF PULSE NUCLEAR RADIATION ON STEP RECOVERY DIODES. Lokerson, David T. (Harry Diamond Labs., Washington, D. C.). Jan. 1967. 29p. (HDL-TR-1339; HDL-16100). CFSTI.

The nuclear radiation effects on the reverse breakdown voltage, reverse leakage current, series resistance, transition time, storage time, and carrier lifetime of two step recovery diodes were measured. Twenty-millisecond triangular radiation pulses with fluences above 10 keV of 6.5×10^{11} to 7.5×10^{13} neutrons per square centimeter were used to provide a total fluence of 2.6×10^{14}. Of the diode parameters mentioned, only the minority carrier lifetime (which is a fundamental parameter that determines the storage time) was measureably affected by the radiation. A simple radiation damage model was used to generate a functional relationship between the carrier lifetime and neutron fluence. The theoretically predicted lifetimes were so nearly equal to measured ones over the range of lifetime and fluence levels tested, that accurate, real-time, remote-reading fluence measurements could probably be made using this step recovery diode as a transducer. (auth) (TAB)

415 (AD-648453) RADIATION EFFECTS IN THIN-FILM TRANSISTORS. Quarterly Report No. 1, September 1-November 30, 1966. Honnold, V. R.; Thomas, G. D.; Berggren, C. C. (Hughes Aircraft Co., Fullerton, Calif.). Feb. 1967. Contract DAAB07-67-C-0052. 33p. (FR-67-10-62; ECOM-0052-1). CFSTI.

The purpose of this program is to improve the radiation response of silicon-on-sapphire (SOS) thin film transistors by device variations selected on the basis of prior work and device analysis. The response will be related to a selection of design variations that will minimize the radiation response to ionizing and displacement producing radiation. The program consists of a statistically designed radiation experiment on a set of devices incorporating selected design variations, together with the development of the necessary design equations. During the first quarter, the statistically designed experiment was developed based on a 2 to the 5th power factorial plan. A computer program was developed for data reduction according to principles of the analysis of variance. In addition, the basic design equation was developed from charge control theory. (auth) (TAB)

416 (AD-648643) RADIATION EFFECTS IN THE DIELECTRIC MATERIALS. Quarterly Report No. 1, September 1-November 30, 1966. Overmeyer, R. F. (General Dynamics Corp., San Diego, Calif. General Atomic Div.). Contract DA-28-043-AMC-02446(E). 27p. (GA-7580; ECOM-02446-1). CFSTI.

Irradiation experiments to verify theories of transient radiation effects in insulators are discussed. High-energy electron, proton, and neutron irradiations of specially designed Mylar capacitors are planned. Experiments designed to measure polarization and secondary emission effects in thin-film capacitors and thin-film circuitry on sapphire substrates are described. Initial results of irradiation of Lucite samples by electrons from a 3-MeV flash x-ray machine indicated internal discharge resulting from strong nonuniform electrical fields created in the material by the radiation; also listed are other materials used in electronic equipment that are to be tested in this manner. Ion-implanted electrodes on a Mylar capacitor indicated better carrier injection characteristics than foil contacts to the same material, but some polarization effects attributable to the contacts still remained. (auth) (TAB)

417 (HMI-B-62) WIRKUNG IONISIERENDER $^{60}Co-\gamma$-STRAHLUNG AUF MOS- UND MNS-FELDEFFEKT-TRANSISTOREN. (Effects of Ionizing $^{60}Co-\gamma$-Irradiations on the Properties of MOS- and MNS-Field Effect-Transistors). Wagemann, H. -G. (Hahn-Meitner-Institut fuer Kernforschung, Berlin (West Germany)). July 1967. 80p. (In German). Dep.

An introduction of the physical aspects of and measurement techniques used to determine the effects of gamma radiation on the properties of MOS- and MNS-FET transistors. The electric characteristics of MNS- and MOS-FET's being irradiated by a 3000 Ci ^{60}Co source is discussed by means of curve families, transconductance, gate capacitance, and surface recombination velocity. The change in the electric charge of the insulating layer and at the interface between the semiconductor and insulator is considered. (auth)

418 (N-67-18545) COMPONENTS IRRADIATION TESTING NO. 19, GAMMA IRRADIATION OF 2N914, 2N918, S2N930, 2N2192, AND 2N2369 TRANSISTORS. (Lockheed-Georgia Co., Marietta). Oct. 1966. Contract NAS8-5332. 106p. (NASA-CR-82010; ER-8623). CFSTI.

NPN silicon planar epitaxial transistors were subjected to gamma irradiation and failure points (gamma dose when 50% degradation of h_{FE} occurred) were determined. The specimens were then temperature annealed and gamma irradiated a second time to failure along with type S2N930 specimens from a previous test. Investigations were made on possible correlations between pre-irradiation values h_{FE}, T_o and I_{EBO} and radiation tolerance exhibited during the first irradiation. Recovery of radiation induced degradation of h_{FE} at room temperature after small doses of gamma irradiation was investigated, and comparison was made between failure points shown during the first irradiation and those shown during the second irradiation. Test results indicated that NPN silicon transistors can be pre-selected for use in a gamma radiation environment by subjecting the devices to comparatively small doses of gamma radiation and computing percentage losses of h_{FE}. The pre-selected devices will have a minimum radiation lifetime about one order of magnitude, or more, greater than the screening dose. (auth)

LIFE SCIENCES

Biochemistry, Physiology, and Molecular Biology

Refer also to abstracts 493, 500, 520, 526, 542, 545, 568, 588, and 591.

419 (AD-648223) EFFECTS OF IONIZING RADIATION ON THE CONCENTRATION OF AMINO COMPOUNDS IN RAT PLASMA. Craft, Charles E.; Winstead, Jack A. (School of Aerospace Medicine, Brooks AFB, Tex.). Jan. 1967. 11p. (SAM-TR-67-8). CFSTI.

Concentrations of 28 different amino compounds, were measured in the plasma of normal and irradiated rats. Preliminary results indicated a 50% decrease in the concentration of the amino compounds during the first 24 hours, and an additional decrease of 48 hours postirradiation. Two amino acids, lysine and serine, showed the greatest decrease in concentration after radiation exposure. Significant changes in the concentration of amino compounds in blood plasma after exposure to ionizing radiation were clearly indicated. (auth) (TAB)

420 (COO-1339-16) A STUDY OF FISSION PRODUCT LEVELS AND METABOLISM IN FOOD PRODUCING ANIMALS AS DETERMINED BY WHOLE BODY COUNTING. Progress Report, August 16, 1966–August 15, 1967. (Illinois Univ., Urbana). Aug. 15, 1967. Contract AT(11-1)-1339. 18p. Dep. CFSTI.

Progress is reported on studies concerned with the kinetics of the exchangeable calcium pool in dairy goats; the goats were injected with ^{45}Ca and the effects of dietary Ca : P ratios, growth, and thyroparathyroidectomy were investigated. Progress is also reported on studies concerned with the retention of ^{85}Sr in swine as a function of age, dietary Ca : P ratios, and breed. (B.H.S.)

421 (NYO-910-57) RADIATION STUDIES. I. FREE RADICAL PRODUCTION IN BIOLOGICALLY SIGNIFICANT COMPOUNDS. II. EXPERIMENTAL STUDY OF ELECTRON SPECTRA INSIDE IRRADIATED TISSUE FROM INTERNALLY LOCATED RADIONUCLIDES. III. THEORETICAL INVESTIGATION OF ELECTRON LET SPECTRA AND DOSE RELATIONSHIP FOR IONIZING RADIATION. Progress Report, May 1, 1966–May 1, 1967. Laughlin, John S.; Pullman, Ira S.; Kessaris, Nikitas D. (Sloan-Kettering Inst. for Cancer Research, New York). Aug. 15, 1967. Contract AT(30-1)-910. 10p. Dep. CFSTI.

Progress is reported on the following studies: protective mechanisms in x-irradiated systems of sulfhydryl compounds with nucleic acids; electron spin resonance spectroscopy of irradiated bone samples; studies on negative ions of polycyclic hydrocarbons; and ESR spectra of uv-irradiated purine N-oxides. (H.L.W.)

422 (RLO-1547-4) SELECTIVE INHIBITION OF ION ABSORPTION BY URANYL. Mason, Benjamin Jordan (Oregon State Univ., Corvallis). June 1967. Contract AT(45-1)-1547. 174p. Dep. CFSTI.

Thesis.

The effects of uranyl (UO_2^{++}) on the absorption of Li, Na, K, Rb, and Cl were evaluated. Results showed that at UO_2^{++} concentrations above 1×10^{-1} milliequivalents per liter and pH's above 4.5, uranyl selectively inhibited K and Rb absorption but had essentially no effect upon Na and Li. Under these same conditions it was concluded that uranyl polymers such as $(UO_2)3(OH)_4^{++}$ were formed. It was suggested that these polymers produce inhibition of K and Rb absorption. When the pH was below 4.0 and the UO_2^{++} concentration below 1×10^{-2} milliequivalents per liter the simple UO_2^{++} cation was the predominant form of uranyl. Under these conditions uranyl acted in a fashion similar to many of the other divalent cations in that it stimulated the absorption of K and Rb (and to some extent Na) from single-alkali cation solutions. When K and Na were both in a test solution at pH 5, the simple UO_2^{++} cation stimulated K but slightly inhibited Na absorption. By pre-treating root samples for thirty minutes in a 1 milliequivalent uranyl solution the absorption of K could be greatly reduced and the absorption of Na stimulated. These effects of the UO_2^{++} could be completely reversed by subsequently treating the pretreated tissues with EDTA for one hour. Addition of UO_2^{++} to root tissues resulted in a slight reduction in the rate of respiration and produced a marked inhibition of K absorption but had no effect upon Na absorption. Results suggest that there are at least two carriers transporting Na and K. One of these carriers was inhibited by the higher uranyl concentrations at pH's above 4.5. This carrier shows a "preference" for K. The second carrier was unaffected by UO_2^{++} and showed a "preference" for Na. When only one of this pair of ions was present it could travel via either of the carriers. Competition of K with Na was greatest during absorption via the "UO_2^{++}-sensitive" carrier. Na competition with K was greatest during transport via the "UO_2^{++}-resistant" carrier. It is suggested that UO_2^{++} may bind to a phosphate containing organic compound that is either the K carrier or a compound closely related to this carrier. (auth)

423 (TID-23955) CHEMICAL ENVIRONMENT OF PLANT ROOTS AS A FACTOR IN THE UPTAKE OF RADIO NUCLIDES BY PLANTS. Final Summary Report. Graham, Ellis R. (Missouri Univ., Columbia). [June 26, 1967]. Contract AT(11-1)-1014; 20p. Dep. CFSTI.

Summaries are presented of investigations concerned with the effects of mineral and organic colloids; radioisotope saturation; content of cations, hydrogen ions (pH), nitrogen, and salts; and soil microorganisms on the distribution of fission products in soils and the uptake of fission products from the soil by garden peas, rye, and soybeans. (B.H.S.)

424 (UR-49-839) CALCIUM AND BARIUM SYSTEMS ANALYSIS IN THE GUINEA PIG. Cuddihy, Richard George (Rochester Univ., N. Y. School of Medicine and Dentistry). 1967. Contract W-7401-eng-49. 112p. Dep. CFSTI.

Thesis.

The calcium reservoirs and internal calcium and barium fluxes were studied in the guinea pig as a function of the age of the animal; calcium reservoirs and fluxes are described in the terms of an open, two compartment, kinetic model. The magnitudes of the calcium reservoirs in the guinea pig and the fluxes between these reservoirs were determined from measurements of blood plasma, urine, fecal and total body radioactivity following the injection of ^{45}Ca and ^{133}Ba. These isotopes were also administered by stomach tube in order to obtain estimates of gastrointestinal absorption. The rates of new bone formation (accretion) and the rates of bone resorption were also calculated from the parameters of the kinetic model. The results of the analysis indicated that during the period of rapid growth, 25 days of age to 180 days of age, the gastrointestinal absorption of calcium was 277 ± 28 mg Ca per day, bone accretion was 190 ± 9 mg Ca per day, and bone resorption was 122 ± 19 mg Ca per day. The values of these parameters decreased at maturation and were determined to be 195 ± 8 mg Ca per day, 53 ± 9 mg Ca per day and 53 ± 9 mg Ca per day, respectively, from 234 to 500 days of age. The renal clearance of calcium increased from 35 mg Ca per day at 25 days of age to 143 ± 16 mg of Ca per day between 234 and 500 days of age. The endogenous fecal calcium excretion of calcium was determined to be 8.2 ± 2 mg Ca per day between 25 and 180 days of age and 23 ± 4 mg per day between 234 and 500 days of age. The magnitudes of these fluxes calculated from the ^{133}Ba data are qualitatively similar to the calcium fluxes. However, the ratios of the fluxes calculated from the two sets of data showed considerable variations among different animals. The analysis of the results of this investigation indicated that compartmental theory is applicable to the study of calcium kinetics. However, the open, two compartment model should be modified to include one additional, slowly exchanging, calcium compartment. This modification of the model, suggested on the basis of tracer retention data, could aid in clarifying the meaning of the accretion rate that is calculated by such model systems. It was also concluded that barium isotopes cannot be used in this manner for the quantitative estimation of calcium kinetic parameters. (auth)

425 (AEC-tr-6726) TRANSPLANTATION IMMUNITY AND RADIATION CHIMERAS. Petrov, R.; Zaretskaya, Yu. Translation of Transplantatsionnyi Immunitet i Radiatsionnye Khimery, Atomizdat, Moscow, 1965. 192p. (IPST-Cat.-1879). CFSTI. JCL $13.00 fs, $5.87 mf.

The transplantation of tissues in irradiated animals is discussed with emphasis on immune reactions to transplanted hematopoietic tissues in experimental animals and man. Each of the nine chapters is prepared by a different author and the literature is reviewed and experimental results are reported. Topics discussed include transplantation immunity; host-versus-graft reactions; the effects of x radiation on transplantation immunity; the effects of x radiation on immunological tolerance; the therapeutic effectiveness of hematopoietic tissue transplants in irradiated animals; the biology of radiation chimeras; factors influencing the transplantation of hematopoietic tissues in radiation chimeras; tissue culture studies of radiation effects on immune reactions in cells; and the effects of radiation injury on immune reactions in animals. (771 references.) (C.H.)

426 RADIATION-INDUCED CHANGES IN MITOSIS AND NUCLEIC ACID SYNTHESIS. Nagy, E. J. Elekes, I. Radiobiol. Radiother., 8: 229-37(1967). (In German).

Budding cells of yeast were radioresistant when treated in the lag period or the budding phase with uv or x rays. Cells could not be inactivated by ^{32}P or by lack of oxygen. Experiments on incorporation of ^{32}P in DNA of dividing cells showed that DNA synthesis was inhibited by mitosis-inhibiting doses when the amount of DNA was twice the premitotic value. Effects of radiation on phosphate fractions of cells were also studied. (H.L.W.)

427 MICROBEAM AND PARTIAL CELL IRRADIATION. Smith, C. L. (Cambridge Univ., Eng.). Int. Rev. Cytol., 16: 133-53(1964).

The effects of localized uv irradiation on cell components are reviewed with special attention to the following topics; recently described techniques for carrying out microbeam or partial-cell irradiations; morphological effects produced by partial cell irradiation, including paling, spindle disappearance, phragmoplast disappearance, and other chromosomal effects; morphological effects following irradiation of the nucleus, nucleolus, and cytoplasm; and biochemical effects of partial cell irradiation. (BBB)

428 FRACTIONATION OF STABLE ISOTOPES BY MICROORGANISMS. Ivanov, M. V. Microbiology (USSR) (Engl. Transl.), 35: 638-40(July-Aug. 1966).

Aspects of the biological separation of isotopes are discussed. In certain reactions, both of energy and constitutive metabolism, molecules of the same chemical compound, differing only in isotopic composition of the elements contained in them, are utilized by microorganisms at different rates. As a result of this, the products of certain biological processes are enriched in some isotopes and impoverished in others. More intensive consumption of lactate containing the light isotope of carbon, ^{12}C, that occurs during the growth of anaerobic sulfate-reducing bacteria, led to the liberation of carbon dioxide that was enriched by 0.5 to 1.3% in the light isotope. Even more enrichment with light carbon was observed in the production of methane in a medium containing methanol and contaminated with sea silt. The maximum enrichment of the methane formed with the light isotope ^{12}C reached 9.4% in comparison with the methanol used. Fractionation of the stable isotopes of sulfur (^{32}S and ^{34}S) which occur during microbiological reduction and oxidation of inorganic sulfur compounds is also considered. In the growth of sulfate-reducing bacteria, there was an intensive separation of ^{32}S and ^{34}S; the light isotope was concentrated in the hydrogen sulfide formed by the bacteria, while the less utilized isotope, ^{34}S, is correspondingly accumulated in the residual sulfates. The degree of fractionation of ^{32}S and ^{34}S depended upon various conditions for culturing of the bacteria, and in growth on media with an organic substance. As a rule, the greatest separation of the isotopes was observed when the formation of hydrogen sulfide by the bacteria was slow. (BBB)

429 EFFECTS OF X-RAY IRRADIATION ON HISTOCHEMICAL REACTIONS IN RAT ADRENALS. Brzezinski, Ryszard (Medical Academy, Poznan, Poland). Polish Endocrinol., 17: 176-87(1966).

The effects of whole-body x irradiation of Wistar rats on histochemical reactions in the adrenals were studied. The results showed that single doses of 700 R enhanced and single doses of 1200 R decreased the rate of biosynthesis of cortico-steroids in rat adrenal cortex. At 24 hr after 700-R irradiation the adrenal cortex showed appreciable morphologic changes. Changes in the zona arcuata of adrenal cortex stained with hematoxylin-eosin included abnormalities of the cell nuclei, mainly peripheral displacement of nuclear chromatin and nucleoli. In the zona arcuata and external portion of zona fasciculata mitochondria were fewer in number or even absent. The nuclei of cells devoid of mitochondria also showed pyknotic changes. Reactions for lipids were weaker than in controls particularly within the zona fasciculata and also in the zona reticularis. The sudanophobe layer was atrophied. Simultaneously, there was a decrease in the reaction for phospholipids in the zona fasciculata. After 700 R a marked involution of Golgi apparatus was seen. After both 700 and 1200 R reactions for steroids containing α-ketol groups were decreased in all adrenal cortical zones. Both doses also reduced the activity of acid phosphatase and caused displacement of this reaction toward the cell periphery. In both experimental groups adrenal activity of acid phosphatase was slightly higher than in controls; the most evident rise in the activity was observed within the zona arcuata. Following irradiation with 700 or 1200 R, reactions for ATPase and DNase II were decreased. (BBB)

430 ENTERAL UPTAKE AND RENAL EXCRETION OF TRITIUM-LABELED WATER IN ADULT RATS. Herzer, R.; Haberich, F. J. (Freie Univ., Berlin). Pfluegers Arch. Ges. Physiol., 292: 277-87(1966). (In German).

Metabolism of ^3H_2O was studied in rats using a special technique whereby indwelling catheters were placed in the duodenum, permitting the later hydration with ^3H_2O of the unanesthetized animals. The diuresis was registered by a drop counter, and the activity of the urine was determined by a liquid scintillation counter. After hydration with ^3H_2O, three phases could be distinguished with respect to the urine activity: distribution, saturation, and elimination. The distribution phase was independent of the given volume but showed some retardation with increasing osmolarity of the fluid used for hydration. The ^3H activity value during saturation could be used to calculate the water content of the whole body. If body weight was considered, then dehydration and hyperhydration processes could be determined. The elimination of the tritium activity was due to the turnover of water and hence to the drinking habits of the animals. Under normal housing and feeding conditions the half time of elimination was three to four days. (BBB)

431 ON THE EXCRETION OF ^{131}I IN THE BRONCHOTRACHEAL SECRETION OF LABORATORY ANIMALS AND THE EFFECT OF DRUGS. II. Hoebel, M.; Asmar, F.; Krueger, F. W.; Maroske, D. (Univ., Heidelberg). Arch. Int. Pharmacodyn., 168: 116-40(July 1967). (In German).

Investigation on radioiodine metabolism in the bronchotracheal system of guinea pigs and rats was carried out with $Na^{131}I$ and ^{131}I-labeled L-thyroxine. Radioiodide was actively secreted into the respiratory tract fluid, since ^{131}I concentration in the secreted material of guinea pigs and of rats, respectively, was up to 15 and 3 times higher than in plasma. There was no active transport of ^{131}I-labeled L-thyroxine. The active transport of radioiodide was inhibited in animals pretreated with $NaClO_4$ or NaSCN. It was significantly reduced when pretreatment with KI or 1-methyl-2-mercaptoimidazole was carried out for several days. Pilocarpine intensified the secretion of ^{131}I into the respiratory tract fluid. Ether, 1-methyl-2-mercapto-imidazole, pretreatment with thyrotropic hormone, and thyroidectomy 4 weeks before experiment had no effect on ^{131}I secretion. Concentrated radioiodide could be removed from the trachea by $NaClO_4$ and NaSCN. The volume of the bronchotracheal secretion was increased by pilocarpine, KI, and, probably, by pretreatment with 1-methyl-2-mercapto-imidazole. Eighty-seven references are cited. (BBB)

432 GAMMA IRRADIATION OF DEOXYRIBONUCLEIC ACID IN DILUTE SOLUTIONS. II. MOLECULAR MECHANISMS RESPONSIBLE FOR INACTIVATION OF PHAGE, ITS TRANSFECTING DNA, AND OF BACTERIAL TRANSFORMING ACTIVITY. Summers, William C.; Szybalski, Waclaw (Univ. of Wisconsin, Madison). J. Mol. Biol., 26: 227-35(June 14, 1967).

Free phage ϕ29, its infectious DNA, and transforming DNA of the Bacillus subtilis host were subjected to ^{137}Cs γ irradiation in dilute aqueous buffer. Radioinactivation of transforming activity was exponential. The mean inactivation dose (D_{37}) in four different experiments with four different DNA preparations ranged from 3.5 to 4.2 krad with an average of 3.8 krad. Inactivation rates were highly dependent on DNA concentration, since under these conditions DNA exerted a self-protective effect. At a concentration of 200 μg/ml the D_{37} was eight krad. The radioprotective effects of cysteine and polyhydroxyl alcohols for transforming DNA irradiated in dilute solution were demonstrated. The D_{37} values in the presence of these compounds were increased by factors of 2 to 19. Radioinduced inactivation of phage and of its extracted DNA (transfecting activity) correlated with double-strand scissions, whereas transforming activity was lost as the result of single-strand breaks in DNA. While the single-strand breaks in phage DNA were probably repaired the double-strand scissions disrupted the continuity of the phage genome and were generally not repaired under conditions of single infection. On the other hand, single-strand breaks in transforming DNA seemed to prevent the integration of donor DNA, an obligatory step in bacterial transformation that apparently depended on the integrity of the single strands of the DNA. (BBB)

433 THE INFLUENCE OF GAMMA RADIATION ON CARBOHYDRATE AND CITRIC ACID CYCLE METABOLISM IN CARROT TISSUE. Bourke, J. B.; Massey, L. M. Jr. (Cornell Univ., Geneva, N. Y.). Contract AT(30-1)-3274. Radiat. Res., 31: 783-95(Aug. 1967). (NYO-3274-6).

A study of the effect of ^{60}Co γ radiation on the metabolism of glucose and various organic acids by carrot tissue was conducted. Radiation resulted in the increased absorption of glucose and pyruvate and the decreased absorption of acetate and succinate. Only a slight effect on glucose and pyruvate catabolism was found, but there was an increase in acetate and a decrease in succinate catabolism. Radiation produced a reduction in the anabolic utilization of all substrates. This included a reduced lipid synthesis from acetate and a net accumulation of this substrate within the tissues. The evidence points to the tricarboxylic acid cycle as being the

source of radiation-accelerated CO_2 evolution. It is postulated that a relatively radiation-resistant bypass system is present in carrots which is capable of circumventing the radiation-depressed succinate utilization. The high-level-radiation degradation products of glucose produced no toxic effects on glucose metabolism. (auth)

434 STUDIES ON INCORPORATION OF ^{3}H-THYMIDINE IN ARBACIA EGGS UNDER HYDROSTATIC PRESSURE. Zimmerman, A. M.; Silberman, L. (Univ. of Toronto. Marine Biological Lab., Woods Hole, Mass.). Exp. Cell Res., 46: 469-76(June 1967).

Fertilized eggs of Arbacia punctulata were placed into ^{3}H-thymidine-sea water solution (1–2 μC/ml) and subjected to pressures of 5000–15,000 lb/in^2 at 20°C for durations of 10–60 min. Immediately after the release of pressure, the eggs were fixed, embedded, sectioned and subjected to autoradiographic procedures. The uptake of ^{3}H-thymidine was compared in the pressurized eggs and non-pressurized controls. Eggs which were placed in ^{3}H-thymidine but not pressurized showed incorporation of the isotope only in the interval from 15–30 min after insemination, corresponding to the time from syngamy to early streak. There was no evidence of ^{3}H-thymidine incorporation into the pronuclei during the presyngamy period. However, eggs in which pronuclear fusion had been inhibited by a pressure of 5000 lb/in^2 for 30–60 min did show isotope incorporation. It was also found that whereas 5000 lb/in^2 did not block DNA synthesis even in the face of cessation of morphological mitotic activity, pressures of 7500 lb/in^2 and greater did inhibit DNA synthesis. The results are discussed in terms of the effects of pressure on development and the independence of the DNA synthesis cycle and cell division. (auth)

435 CHANGES OF THE LIPID BALANCE IN MATERNAL LIVER, FETAL LIVER, PLACENTA, AND THE WHOLE FETUS OF RATS FOLLOWING TOTAL-BODY IRRADIATION WITH 800 R. Winkler, L. (Friedrich Schiller-Univ., Jena, Ger.). Acta Biol. Med. Ger., 18: 457-64(1967). (In German).

At 24 hr after total-body x irradiation of pregnant rats with 800 R on day 19 of pregnancy, the content of triglycerides in the maternal liver, fetal liver, and placenta rose 1.7, 4, and 1.4 fold, respectively, compared with sham-irradiated control animals. This increase in triglycerides was associated with an increase in linoleic acid level of this fraction in fetal and maternal liver. The absolute amounts of linoleic acid in material and fetal liver increased 2.3 and 8 times, respectively, compared with controls. The increase in placental triglycerides did not involve an alteration of the fatty acid pattern. In the whole fetus the amount of neutral fat fatty acids rose by 70%, while the absolute amount of linoleic acid in the total neutral fat doubled. The increase in total fatty acid in the fetus was identical with the increase in neutral fat. Neutral fat additionally formed in the fetus after irradiation was equally distributed between liver and peripheral tissues. The additional linoleic acid was distributed between these 2 sites at a ratio 5:3. The results are discussed in relation to the metabolic pathways of fat accumulation, based on the fact that linoleic acid cannot be synthesized in higher animals. The triglyceride accumulation in the fetus presumably was due to an increased supply of maternal fatty acids. (BBB)

436 RADIATION RESISTANCE OF LONG-LIVED LYMPHOCYTES AND PLASMA CELLS IN MOUSE AND RAT LYMPH NODES. Miller III, John J.; Cole, Leonard J. (Naval Radiological Defense Lab., San Francisco). J. Immunol., 98: 982-90(May 1967).

Adult male C57B1/10J mice and adult female Sprague Dawley rats were immunized with typhoid-paratyphoid A and B vaccine and then were given twice daily injections of ^{3}H-thymidine for 4 days into the hind footpad. Thirty days later the mice were exposed to 850 or 500 rad and the rats to 850 rad of x rays. Despite a marked, generalized destruction of lymphocytes, the aortic nodes of the mice and the popliteal nodes of the rats had larger values for per cent of small lymphocytes labeled in the period immediately following irradiation than did the nodes from nonirradiated control animals. The mean grain counts of the ^{3}H-labeled small lymphocytes from irradiated animals were equal to or larger than those from nonirradiated animals. These results demonstrate relative radioresistance of long-lived, lymph node lymphocytes. Large numbers of persistently labeled plasma cells were also found in lymph nodes after irradiation. No difference could be found in the numbers or distribution of labeled plasma cells in lymph nodes from irradiated and nonirradiated mice. There may have been a loss of a small proportion of the long-lived plasma cells present in the rat lymph nodes. The ability of plasma cells to survive irradiation may explain the radioresistance of established antibody production. (BBB)

437 FUNCTIONAL AND MORPHOLOGICAL CHANGES IN THE THYROID GLAND AFTER ULTRASONIC IRRADIATION. Hrazdira, Ivo; Konecny, Milan (Purkyne Univ., Brno). Amer. J. Phys. Med., 45: 238-43(1966).

The effect of ultrasonic (800-kcps) irradiation on ^{131}I uptake by the thyroid gland was studied in rabbits. To test the influence of ultrasound in repeated irradiation on 3 consecutive days, animals of the 1st group were irradiated for 5 min with an intensity of 1 and 2 w/cm^2. The uptake of radioiodine in the thyroid after an irradiation at a low intensity was slightly lower than normal and the start of uptake was slower. Irradiation of higher intensity clearly suppressed the uptake of the isotope in the thyroid. The ^{131}I uptake curves were in agreement with the results of histologic and autoradiographic examinations of the thyroid. In slightly irradiated animals a decrease in size of the follicles and in the amount of follicular colloid was observed. In autoradiographs the density of blackening over the follicular colloid was also slightly diminished. In heavily irradiated animals the histologic and autoradiographic preparations showed signs of a significantly decreased function. In the second group of animals the influence of a single, and of repeated ultrasound doses (intensity 1 w/cm^2) on the course of radioiodine uptake was examined. Whereas repeated irradiations caused a decrease in ^{131}I uptake, single irradiation at the same intensity caused a rapid increase at the beginning of the uptake followed by later decrease. Treatment with thyrotropin caused a greater decrease in ^{131}I uptake than in untreated irradiated rabbits. (BBB)

438 THE USE OF RADIOACTIVE ISOTOPES IN STUDIES ON PHAGOCYTOSIS IN VITRO. Brzuchowska, W. Arch. Immunol. Ther. Exp., 14: 129(1966).

An Escherichia coli strain was used that when propagated on simple media incorporated relatively large amounts of labeled sodium acetate. Labeled bacteria from the cultures were washed with physiological saline, and suspensions were prepared that exhibited radioactivity of 66,670 imp/min/ml of suspension on the average. Suspensions of guinea pig leukocytes were prepared by a method based on selective agglomeration of red blood cells in polyvinyl alcohol. In this way, autoabsorption of radiation was markedly reduced. After performing the phagocytic test, the leukocytes were separated from the unphagocytosed bacteria by washing the phagocytes with physiological saline. From the washed phagocytes, preparations for estimation of radioactivity were prepared. Results were expressed as percentages of radioactivity used in the reaction with suspensions of labeled bacteria. The method allowed simultaneous accurate experiments in a number of variants and in duplicate. Minimal amounts of serum and reagents were required. The method was objective and suitable for quantitative studies on phagocytosis. (auth)

439 CHANGES IN ^{3}H–THYMIDINE INCORPORATION INTO THE DNA BY HISTONES FROM NORMAL AND TUMOR TISSUES. Holoubek, V.; Hnilica, L. S. (Univ. of California, San Francisco, Univ. of Texas, Houston). J. Nat. Cancer Inst., 39: 187-91(Aug. 1967).

Attempts were made to isolate a factor from tumor tissue which, after injection, enhances the ^{3}H-thymidine incorporation into the DNA of mice. This factor was in the cell nuclei and was extractable together with acid-soluble nuclear proteins (histones). Additional purification showed that this factor was either closely bound with the very lysine-rich histone (F1), or it was this histone itself. Acid-soluble nuclear proteins prepared from liver and thymus did not influence the incorporation of ^{3}H-thymidine into DNA after injection. The very lysine-rich histone (F1) in these extracts was in an inactive form. It could be activated by separation from other acid-soluble nuclear proteins. Purified, the very lysine-rich histone (F1) enhanced the ^{3}H-thymidine incorporation into DNA, regardless of its being prepared from tumor or nontumor tissues. By enhancing the incorporation of ^{3}H-thymidine into DNA, after injection, the very lysine-rich histone (F1) significantly differed from arginine-rich (F2aF3) and lysine-rich (F2b) histones that suppressed the ^{3}H-thymidine incorporation. (auth)

440 THE EFFECT OF IRRADIATION ON SUB-CELLULAR COMPONENTS. METAL ION TRANSPORT IN MITOCHONDRIA. Wills, E. D. (St. Bartholomew's Hospital, London). Int. J. Radiat. Biol., 11: 517-29(1966).

Mitochondria from rat liver irradiated with electron doses within the range 2 to 100 krad readily lose potassium ions when incubated in media containing low concentrations of potassium (10 mM) for short periods at 25° or 37°. When incubated in media containing 0.1M potassium, irradiated mitochondria take up more potassium than do control mitochondria. Active uptake of calcium from a Ca^{2+}-containing medium is also inhibited by irradiation and Ca^{2+} ions are lost if irradiated mitochondria are incubated in a Ca^{2+}-free medium. Effects on the transport of both K^+ and Ca^{2+} are observable after doses of 5 krad, and are believed to be a direct result of damage to the mitochondrial membrane and not to inhibition of mitochondrial ATP-ase or to inhibition of oxidative phosphorylation. (auth)

441 DISTRIBUTION OF THE ACTIVITY OF TWO HYDROLYTIC ENZYMES IN RAT THYMIC CELLS AFTER TOTAL-BODY IRRADIATION. Toro, I.; Rappay, Gy.; Bacsy, E. (Inst. of Experimental Medicine, Budapest). Ann. Histochim., 12: 91-6(Jan.-Feb.-Mar. 1967).

The distribution of acid phosphatase and nonspecific esterase in the reticular cells of the thymus was studied in normal rats and in rats irradiated with a 450-R, sublethal dose of x rays. It is shown that, on the basis of the ratio between the activities of the two enzymes, that at least two different types of reticular cell could be separated in the control as well as in the irradiated thymus. With the disappearance of the radiation-damaged cells on the fourth day after irradiation the radioresistant cells appeared to have more activity. This increased activity was most evident in the cells of the capsule and septa. It could not be established, however, to what extent shrinkage of the thymus caused an increase or decrease in the number of the enzymatically active cells and if enzyme activity of some cells changed in intensity. At 4 hr, and 1 and 4 days after exposure, thymocytes in the irradiated thymus disappeared gradually. One of the reticular cell types could easily be identified by the many digestive vacuoles within the cytoplasm. The cells of that type stained almost selectively for lipids. The more thymocytes were seen to be disappearing, the more nonphagocytic reticular cells and Hassal's corpuscles appeared. The latter contained occasional lipid droplets. Eleven days after irradiation the thymus was repopulated and the cellular pattern approached normal, except for more lipid-containing cells than in the nonirradiated gland. (BBB)

442 A STUDY OF THE EFFECTS OF SINGLE-DOSE X IRRADIATION OF LIVER IN ALBINO RATS. Agarwall, S, K. Mehrotra, R. M. L. (Medical Coll., Lucknow, India). Indian J. Pathol. Bacteriol., 9: 175-81(Apr. 1966).

Histologic and biochemical changes in the livers of rats exposed to single doses of 3000 and 25,000 R were investigated at 1, 5, and 10 days postirradiation. An increase was seen in wet liver weight and water content of 3000-R irradiated animals at 5 and 10 days. There was an increase in lipids at 24 hr whereas a significant decrease was found at 10 days. Liver glycogen showed a significant increase at 24 hr and total nitrogen at 5 days. At other periods there were no significant alterations. One day after 3000-R irradiation, out of the 5 animals studied, only 1 showed a few focal areas of necrosis in the liver parenchyma. The liver cells presented fenestration of cytoplasm in a few animals. The livers of animals killed at 5 and 10 days did not show any change. After 25,000 R there was an increase in the wet weight and water content of the livers at all periods. There was significant increase of lipids at 5 days. A decrease in liver glycogen was observed at 24 hr and an increase at 10 days. A decrease in total nitrogen was observed at 5 and 10 days. The livers of 25,000-R irradiated animals at 24 hr did not show any morphologic alterations. At 5 days, 2 out of 6 animals showed a narrow zone of necrosis in the subcapsular region but there was no inflammatory reaction. The deeper portions of parenchyma did not present any evidence of cell injury. At 10 days, out of 6 animals only 1 showed a thin zone of necrosis on the irradiated surface. There was no inflammatory reaction or regenerative activity around the area. The liver in its deeper regions presented normal histology. It is concluded that the rat liver is highly resistant to x rays, for only mild histologic and biochemical changes were observed in a few animals. (BBB)

443 A METHOD OF ASSAYING IN VIVO THE SURVIVAL OF ULTRAVIOLET-IRRADIATED TUMOR CELLS. Stevens, G. H.; Roe, E. M. F. (Royal Cancer Hospital, London). Photochem. Photobiol., 4: 749-57(Sept. 1965).

The growth of uv-irradiated ascites tumor cells in adult animals that received a total-body dose of x radiation was used as a method to obtain data on the survival of the treated tumor cells. The dose of total-body radiation and its time before tumor cell inoculation were considered to be critical. The optimal dose and time were chosen to be 300 R and 2 days. In assessing tumor cell survival, the analysis of the time of appearance of the resulting solid tumors, using the linear relation between the reciprocal of this time and the logarithm of the number of cells injected, was preferred to probit or to Reed–Muench analysis of the number of tumor takes. The 1/T analysis method yielded better estimates of the survival ratio and required fewer x-irradiated animals. An application of this method to the determination of survival ratios of uv-irradiated Landschuetz ascites tumor cells in 300-R x-irradiated Balb mice is reported. (BBB)

444 PRIMARY ANTIBODY RESPONSE IN ORGAN CULTURES. Globerson, Amiela; Auerbach, Robert (Univ. of Wisconsin, Madison). J. Exp. Med., 124: 1001-16(Nov. 1, 1966).

The effect of 550-R whole-body x irradiation of mice injected with heterologous red blood cells as antigen on the subsequent immune response of lymphoid cells explanted in vitro was studied. In nonirradiated mice, specific antibody formation was elicited in vitro following antigenic stimulation by either sheep (in a total of 472 of 875 cultures) or chick erythrocytes (in 65 of 135 cultures tested). The response was manifested by mouse spleen and lymph node explants whereas thymus cultures were inactive. No agglutinin reaction was detected in any of the irradiated spleen explants, whereas 8 of the 20 controls responded on the 5th day. That the irradiation under these conditions was not preventing antibody formation per se was shown by the fact that spleen cultures from all mice immunized 1 month previous to exposure did form antibodies. Therefore, the response induced in vitro is sensitive to the effect of x irradiation and, such radiosensitivity is not manifested by spleens from donors immunized before exposure. The reaction was characterized as a primary immune response in view of its kinetics as compared to defined primary and secondary responses, the effect of 2-mercaptoethanol on the antibodies formed, its subject to puromycin inhibition, and its sensitivity to x irradiation. (BBB)

445 INCREASED SENSITIVITY TO THE MUSCLE RELAXING EFFECT OF SUCCINYLCHOLINE IN IRRADIATED RABBITS. Belfrage, P.; Schildt, B. (Research Inst. of National Defense, Sundbyberg, Sweden). Acta Anaesth. Scan., 11: 65-75(1967).

The neuromuscular blocking effect of succinylcholine (SCh) was investigated in whole-body irradiated (1100 R or LD_{50}) and control rabbits. Eight days after irradiation, 5 repeated injections of 0.15 mg/Kg body weight SCh were given at 15-min intervals to the anesthetized rabbits. Contractions of the gastrocnemius muscle were recorded in response to electrical stimulation of the sciatic nerve. The results revealed an increased sensitivity of the irradiated animals to SCh. In addition, the systolic blood pressure was significantly lower in the irradiated animals than in the controls. The results are discussed in terms of decreased peripheral circulation and decreased pseudocholinesterase activity, demonstrated previously as effects of irradiation. They were thought to be responsible for the impaired inactivation of SCh as shown in this study. Particular care is advocated when SCh is given to patients exposed to ionizing radiation. (BBB)

446 INFLUENCE OF ROENTGEN IRRADIATION ON THE PROTEIN PATTERNS OF THE BLOOD, BONE MARROW, AND HEPATIC TISSUE OF ALBINO RATS. Notario, A.; Slaviero, G. E.; Zampaglione, G. (Univ., Pavia, Italy). Haematologica, (Pavia), 51: 509-26(1966). (In Italian).

Electrophoretic studies were conducted on protein fractions in rats subjected to single or fractionated whole-body doses of x rays, ranging from 250 to 1500 R delivered over 2 to 8 consecutive days. Serum proteins and soluble proteins of liver and bone marrow were separated on cellulose acetate. Low doses (250 R fractionated over 3 days) tended to increase total serum proteins (from 5.9 g% in controls to 6.4), albumin, α_1- and β-globulins, but to decrease α_2- and γ-globulins. Larger doses tended to decrease total serum protein, albumin, and γ-globulin markedly. Thus, after 1500 R, administered for 6 consecutive days, total protein fell to 5.2 g%. Both absolute and relative values of α_1-, and α_2-, and β-globulins increased after high doses of x rays. Soluble protein fractions in liver cells were not significantly altered after irradiation but in bone marrow soluble protein changes were noted, particularly after high-dose irradiation. Relative values of prealbumin and γ-globulin decreased, while albumin and β-globulin rose. The bone marrow cell albumin/globulin ratio rose from 0.18 in controls to 0.43 in rats receiving the highest dose of x rays. (BBB)

447 ACETYLCHOLINESTERASE ACTIVITY AND PROTEIN CONTENT OF BRAIN AND SPINAL CORD IN DEVELOPING RATS AFTER PRENATAL X IRRADIATION. Maletta, Gabe J.; Vernadakis, Antonia; Timiras, Paola S. (Univ. of California, Berkeley). J. Neurochem., 14: 647-52(June 1967).

Acetylcholinesterase activities and total protein contents in the sensory-motor cortex, hypothalamus, cerebellum, brain stem, and spinal cord were measured in normally developing Long–Evans rats, and after exposure to 100 R x irradiation at 14 days of gestation. Measurements were made at 18 days of prenatal age, and at 2, 9, 23, and 44 days postnatally. In controls, acetylcholinesterase activity progressively increased with age in all brain areas. In the spinal cord, acetylcholinesterase activity increased from 18 days of gestation up to 2 days after birth, remained relatively constant until 23 days, and was lower at 44 days. In prenatally irradiated rats, acetylcholinesterase activity was significantly lower in the sensory-motor cortex at 18 days of gestation and at 2 and 9 days after birth, but not at 23 and 44 days. In the brain stem, acetylcholinesterase activity was tran-

siently decreased at 23 days after birth, returning to control values by 44 days. Enzyme activity of the spinal cord was not altered after irradiation. Total protein content increased progressively with age in all central nervous system areas. After irradiation protein remained at normal values throughout the experimental period. (BBB)

448 EFFECT OF X IRRADIATION ON GLUCOSE METABOLISM IN RAT CEREBRAL CORTEX SLICES. Kay, Robert E.; Chan, Hakchill (Philco Corp., Newport Beach, Calif.). J. Neurochem., 14: 401-3(Apr. 1967).

It was shown that oxidation of glucose in the brain is inhibited by exposure of whole-body x irradiation. Female Charles River CD rats 2 to 3 months of age were deprived of food 24 hr before irradiation and the starvation was continued during the experiment. It was necessary to starve the rats and to conduct 2 experiments independently, each with its own control, because irradiation causes anorexia in the rats, and starvation results in alteration in the metabolism of brain slices. The animals were irradiated with a single dose of 1500 rad of 150-KV x rays. Metabolic studies were conducted in brain slices at various subsequent intervals. At both 24 and 72 hr after irradiation the conversion of U-^{14}C glucose to $^{14}CO_2$ was about 30% less in the irradiated samples, whereas the conversion of U-^{14}C glucose to ^{14}C-lactate was not altered. On the other hand, the net accumulation of lactate was 30 to 40% less in the irradiated samples. Replicate experiments conducted at 24 hr after irradiation gave the same results. The decrease in conversion of glucose-^{14}C to $^{14}CO_2$ due to exposure to radiation was sufficient to account for the increase in glycogen content observed earlier. The data suggested that the biochemical lesion is not in the glycolytic cycle, since conversion to ^{14}C-lactate is not affected, but is concerned with oxidation via the citric acid cycle. The possibility that the decreased conversion of U-^{14}C glucose to $^{14}CO_2$ is due to an increase in glucose pool size is unlikely since the rate of conversion to ^{14}C-lactate was not altered and the amount of glucose substrate added was several hundred times greater than the glucose content of the tissue. The effects on glucose and lactate metabolism may be distinct and separate alterations. (BBB)

449 THE LOCALIZATION OF ANTIGEN IN LYMPH NODES AND ITS RELATION TO SPECIFIC ANTIBODY-PRODUCING CELLS. II. COMPARISON OF ^{125}I AND TRITIUM LABELS. Humphrey, J. H. (National Inst. for Medical Research, London); Askonas, Brigitte A.; Auzins, Ieva; Schechter, I.; Sela, M. Immunology, 13: 71-86(July 1967).

For a study of the detailed localization of antigens the use of a radioactive label has many advantages, especially if it emits both γ rays which facilitate scintillation counting of tissues and fluids, and weak β rays suitable for autoradiography. Iodine-125 appears to be almost the ideal label since it has a convenient half-life of 60 days, emits both γ and relatively weak β rays, and is readily attached in vitro by stable covalent bonds to tyrosine and histidine residues in proteins. Relative value of ^{125}I and ^{3}H labeling of antigens was studied using a branched multichain polypeptide of the type p(Tyr,Glu)-pAla—pLys. It was synthesized from L-lysine, L-tyrosine, L-glutamic acid, and tritium-labeled DL-alanine; the final product, ^{3}H-(T,G)-A—L, had a sp radioactivity of 3 mCi/mg. Its immunological behavior in mice was compared with that of (T,G)-A—L trace labeled with ^{125}I (2 mCi/mb). The ^{3}H-(T,G)A—L was only very weakly immunogenic compared with ^{125}I-(T,G)-A—L, because of its radioactivity, but probably its low tyrosine content. However, autoradiographical studies in the draining lymph nodes after its injection into primed and of unprimed mice revealed no qualitative differences in behavior. When (T,G)-A—L labeled on the same molecules with both ^{3}H and ^{125}I was studied in lymph nodes, selective retention of ^{3}H relative to ^{125}I was observed, explained by the greater susceptibility to peptidase activity of L-tyrosine residues at the ends of the side chains compared with that of the underlying polymeric DL-alanine. (BBB)

450 TRANSFER OF ^{85}Sr THROUGH PLACENTA AND MOTHER'S MILK. II. CHANGES OF SPECIFIC ACTIVITIES IN SUCKLING MICE. Matsusaka, Naonori; Ikeda, Miyoshi; Ohkubo, Yoshio (Tokyo Univ.). Nippon Juigaku Zasshi, 29: 41-6(1967). (In Japanese).

In suckling mice born of ^{85}Sr-contaminated mothers and nursed on breast milk, accumulation of ^{85}Sr increased rapidly after birth. To take growth of the suckling mice into consideration, the sp activities were expressed as percent of dose per mg ash, providing a more exact description of the changes of ^{85}Sr concentration in the suckling mice. During the nursing period, suckling mice showed no significant decrease in sp act. when they were born of ^{85}Sr-contaminated mothers and nursed by their mother's breast milk, or when they were born of normal mothers and nursed by an ^{85}Sr-contaminated foster-mother. In sucklings which were born of an ^{85}Sr-contaminated mother and nursed by an intact foster-mother soon after birth, a significant decrease in sp act. was observed, the value at weaning being much less than 10% of the value at birth. It is pointed out that in maternal-offspring studies with Sr the contamination of sucklings with the Sr in mother's milk is important as well as the contamination of fetus during gestation through placental transferral of Sr. (BBB)

451 EFFECT OF STABLE STRONTIUM ON RADIOSTRONTIUM EXCRETION IN MAN. Spencer, Herta; Lewin, Isaac; Samachson, Joseph (Veterans Administration Hospital, Hines, Ill.). Contract AT(11-1)-1231. Radiat. Res., 31: 876-88(Aug. 1967).

Parenterally administered stable strontium has been shown to be effective in decreasing the radiostrontium body burden in animals, whereas stable calcium is ineffective. In the present study, the effects of intravenously infused stable strontium and stable calcium, used in equimolar amounts as the gluconate, on urinary ^{85}Si excretion were investigated in man under constant and controlled dietary conditions. All patients received a low-calcium diet on the Metabolic Research Ward. A single tracer dose of $^{85}SrCl_2$ was given intravenously on the first day of the control and experimental studies. Infusions of stable strontium and stable calcium were given on three successive days in separate studies, the first infusion being given on the day of administration of ^{85}Sr. The ^{85}Sr plasma levels and the urinary and fecal excretions were determined in the control, the stable strontium, and the stable calcium studies. Both stable strontium and stable calcium increased the urinary excretion of radiostrontium, infusions of stable strontium being somewhat more effective than infusions of stable calcium. Also, after the discontinuation of the stable strontium infusions, the urinary ^{85}Sr excretions remained higher for several days than in the control and the stable calcium studies, stable strontium resulting in a significantly higher 10-day cumulative urinary ^{85}Sr excretion than stable calcium. There was no effect of intravenous stable strontium or stable calcium on fecal ^{85}Sr excretion. (auth)

452 TEMPERATURE DEPENDENCE OF IONIZING RADIATION EFFECT ON DRY HYALURONIDASE. Vollmer, Robin T.; Fluke, Donald J. (Duke Univ., Durham, N. C.). Radiat. Res., 31: 867-75(Aug. 1967).

Dry bovine testicular hyaluronidase in relatively impure preparation has been irradiated with fast electrons at temperatures from 66 to 433°K. On subsequent recovery of the hyaluronidase into solutions it was assayed for enzymatic activity in digestion of hyaluronic acid to yield detectable oligosaccharides. The activity remaining was found to be approximately logarithmic in relation to the electron dose given. With correction for recovered protein the results as a function of temperature can be reasonably fitted by the sum of two terms, one independent of temperature, and the other characterized by an Arrhenius activation energy of about 1100 cal/mole. In relation to similar work with other enzymes, a larger activation energy usually found at higher temperatures is negligible for hyaluronidase. (auth)

453 STIMULATION OF CELL-FREE PROTEIN SYNTHESIS AFTER WHOLE-BODY LETHAL X-IRRADIATION. Corless, Joseph; Gray, Irving (Georgetown Univ., Washington, D. C.). Radiat. Res., 31: 775-82(Aug. 1967).

Protein synthesis by liver microsomes in the presence of the appropriate cofactors, enzymes, and sRNA has been studied following 600 R of whole-body x irradiation of rats. The synthesis, as measured by the uptake of L-leucine-U-^{14}C, increased to a value about 70% greater than controls on day nine postirradiation. During the overall period of observation (day 0 to day 15), the activity of the control systems increased 36%, while that of the experimental systems increased by 114%. When ribosomes and 105,000 × g supernatants from control and irradiated animals were interchanged, increased protein synthesis occurred whenever microsomes from irradiated animals were used. The degree of stimulation was shown to be a linear function of the relative amount of RNA in the microsomal fraction. (auth)

454 EFFECT OF IRRADIATION ON LIPID PEROXIDE FORMATION IN SUBCELLULAR FRACTIONS. Wills, E. D.; Wilkinson, A. E. (St. Bartholomew's Hospital, London). Radiat. Res., 31: 732-47(Aug. 1967).

Nuclei, mitochondria, lysosomes, and microsomes separated from rat liver all form lipid peroxides after irradiation in vitro with electron doses within the range 2 to 100 rads. Little peroxide is formed in each fraction immediately after irradiation, but all fractions form peroxide after incubation at 4, 20, or 37°C. The quantity of peroxide formed in each fraction after identical conditions of irradiation and incubation was microsomes > lysosomes > mitochondria > nuclei when expressed as micromoles of malo-

naldehyde per milligram of nitrogen. After irradiation with 10 krads and after incubation at 4 or 20°C, microsomes formed nearly fifty times as much peroxide as the mitochondria or nuclei. Oxygen is essential during the postirradiation incubation for peroxide formation, and during this incubation water-soluble fragments of peroxidized unsaturated fatty acids are split and liberated into the suspending medium. The relationship of lipid peroxide formation in the subcellular particles to the primary biochemical lesion which occurs after irradiation in vivo is discussed. (auth)

455 THE UPTAKE OF ^{210}Pb BY RESTING AND GROWING HAIR. Jaworowski, Z. (Inst. of Nuclear Research, Warsaw); Bilkiewicz, J.; Kostanecki, W. Int. J. Radiat. Biol., 11: 563-6 (1966).

The incorporation of ^{210}Pb into resting and growing hair was studied in rabbits. It was found that in the telogen (resting) hair the concentrations of ^{210}Pb were from 7 to 137 times lower than in the anagen (growing) hair. The concentrations in the anagen hair were dependent both on the total dose of injected ^{210}Pb and on the mode of dose fractionation. (auth)

456 EXCRETION OF RADIOISOTOPES AND METABOLIC RATIO OF THE STABLE ELEMENTS IN MILK TO MAN. Calapaj, G. G.; Ongaro, D. (Univ., Padua). Acta Isotop., 6: 245-52 (Dec. 15, 1966). (In Italian).

Through experiments carried out on three lots of puerperae, the average observed ratio (O.R.) of ^{90}Sr/Ca and ^{137}Cs/K from the diet to the human milk was measured. Calculated values for the O.R. ^{90}Sr/Ca are less and those for the O. R. ^{137}Cs/K are greater than the unit, showing that a true discrimination process takes place in the human organism for the ^{90}Sr in favor of the Calcium while the opposite process is the case for the ^{137}Cs against the potassium. (auth)

457 A SENSITIVE RADIOMETRIC ASSAY FOR TRYPTOPHAN-5-HYDROXYLASE. Hakanson, Rolf; Hoffman, Gary J. (Univ. of Lund, Sweden). Biochem. Pharmacol., 16: 1677-80 (Sept. 1967).

A simple and sensitive radiometric micromethod for the study of tryptophan-5-hydroxylase is described. Carbon-14-labeled 5-hydroxytryptophan (5-HTP), which is the product of the reaction, is separated from the ^{14}C-tryptophan substrate by thin-layer chromatography and assayed by liquid scintillation counting. The enzyme activity in some tissues of the rat was measured. The pineal gland, which is known to store large amounts of 5-hydroxytryptamine, had the highest activity of all tissues studied. Stomach wall and duodenum had only moderate activities, whereas rat liver was a rich source of a 5-HTP-producing enzyme, possibly identical with non-specific phenylalanine hydroxylase. The enzyme activity of all tissues studied was considerably reduced following homogenization, suggesting that the formation of 5-HTP requires some co-factor, which occurs in high concentration intracellularly. Tryptophan hydroxylase extracted from rat pineals could be reactivated by the addition of a tetrahydropteridine derivative, but only in the presence of 2-meraptoethanol. (auth)

458 GAMMA-IRRADIATION OF NUCLEIC-ACID CONSTITUENTS IN DE-AERATED AQUEOUS SOLUTIONS. III. THYMINE AND URACIL. Khattak, M. N.; Green, J. H. (Univ. of New South Wales, Sydney). Int. J. Radiat. Biol., 11: 577-82(1966).

De-aerated aqueous solutions of thymine and uracil were irradiated by γ-radiation from a ^{60}Co source. Thymine-decomposition products were dihydrothymine, 5-hydroxymethyl uracil, cis and trans thymine glycols and 5 (6) hydroxyhydrothymine. Uracil products were as previously reported. Initial yields of all products identified have been measured. (auth)

459 RADIATION EFFECTS ON ACID PHOSPHATASE AND ELECTROPHORETIC PROPERTIES OF MITOCHONDRIA AND MICROSOME PROTEINS OF NEOPLASTIC CELLS. Dragoni, G.; Raimondi, L. (Univ., Milan. Univ., Padua). Med. Nucl. Radiol. Lat., 9: 351-8(1966). (In Italian).

With the aid of electrophoretic analysis in the free phase, a study was made of the mitochondrial and microsomial proteins of neoplastic cells (ascites hepatoma) of rats before and after x irradiation of the abdomen. The acid phosphatase activity was also determined in the same subcellular structures. The irradiation brought about modifications of the proteins that manifested themselves in the electrophoretic pattern with alterations of shape, appearance, and planimetric value; these alterations were the expressions of phenomena of aggregation and of protein denaturation. Following the irradiation there could also be observed alterations of the phosphatase activity that was increased in the various microstructures and in the supernatant of the neoplastic cells, whereas it was decreased in the corresponding elements of the liver cells of rats with ascites tumors. (auth)

460 SLOPE-CLEARANCE EXAMINATIONS WITH ^{51}Cr-EDTA. Kuni, H.; Graul, E. H. (Philipps Univ., Marburg, Ger.). Atompraxis, 13: 357-60(Aug. 1967). (In German).

Study of kidney function with slope-clearance of glomerular filtrates requires two conditions; rapid mixing in the distribution space, and calculations must be based on a two-chamber model, that necessitates the use of relevant correction factors. In practical calculation of clearance from the disappearance rate, neither normal mixing nor a normal distribution space can be assumed as constants. Calculation of clearance via the injected pulse count is preferable to calculation via the activity eliminated in the urine, since the former is more accurate. ^{51}Cr-EDTA is practically ideal for this clearance method. If indicated, this slope method can provide valuable information. However, because of its basic possibilities of error, it cannot replace the classic steady state method. (auth)

461 THE INTRODUCTION OF RADIOISOTOPES INTO RNA BY METHYLATION IN VITRO. Smith, Kirby D.; Armstrong, John L.; McCarthy, Brian J. (Univ. of Washington, Seattle). Biochim. Biophys. Acta, 142: 323-30(July 18, 1967).

Either ^{3}H or ^{14}C may be introduced at high specific radioactivity into RNA in vitro by treatment with dimethyl sulfate. The procedure is rapid and simple and no degradation of the RNA occurs. The hybridization properties of the methylated RNA compare with those of molecules randomly labeled in vivo. The method is of potential value in cases where low metabolic activity or other biological parameters preclude labeling of RNA in vivo during synthesis. (auth)

462 THE CHEMICAL FORM OF ^{32}P-COMPOUNDS AFTER NUCLEAR RECOIL REACTIONS IN NEUTRON-IRRADIATED NUCLEOTIDES AND DNA. Akaboshi, Mitsuhiko; Maeda, Toshio; Waki, Asako (Kyoto Univ.). Biochim. Biophys. Acta, 142: 285-91(July 18, 1967).

Monodeoxynucleotides, deoxynucleotide triphosphates and DNA were irradiated in a pneumatic tube of the Kyoto University reactor and a study was made of ^{32}P derived from the nuclear reaction ^{31}P(n,γ)^{32}P. When mononucleotides were irradiated, the largest fraction of the ^{32}P appeared in phosphorous acid, and the next largest in phosphoric acid; but when nucleotide triphosphates and DNA were irradiated, most of the ^{32}P appearing in inorganic fractions was found in hypophosphorous acid. When DNA was irradiated, organic ^{32}P-compounds comprised more than 50% of the radioactive material; in the case of mononucleotides, the figure was about 20%, and in the case of nucleotide triphosphates, the organic fraction was small. In irradiated DNA, ^{32}P was released by phosphatase. This suggests that, after the recoil reaction, ^{32}P recombined with the exposed end of the chain. (auth)

463 CHANGES OF SERUM-PROTEIN PICTURE OF THE RAT AFTER WHOLE-BODY X-IRRADIATION: COMBINED EXAMINATIONS BY MEANS OF PAPER AND STARCH-GEL ELECTROPHORESIS. Roesler, B.; Reichel, G. (Biologische Institut der Medizinische, Magdeburg, Ger.). Radiobiol. Radiother., 8: 239-62(1967). (In German).

Sera of totally irradiated male rats were separated by means of paper electrophoresis as well as by one-dimensional and two-dimensional starch-gel electrophoresis and the effects of a whole-body irradiation on the serum-protein picture were examined. After the separation in TEB-buffer according to Aronsson and Gronwall the total protein (6.32 g. percent) for normal serum of rats is distributed as follows: albumin 46.77 percent, α_1-globulin 14.62 percent, α_2-globulin 6.6 percent, β_1-globulin 5.84 percent, β_2-globulin 15.45 percent and γ globulin 10.72 percent. Statistical significant changes for the rats irradiated with 1000 R generally do not occur before the fourth day after irradiation. The significance of variation for the series of 600 R, on the contrary, is clearly reduced. The decrease of γ globulins begins immediately after the radiation insull, whereas the permanent decrease of albumins occurs at the end of the gastrointestinal phase of radiation syndrome. The relative increase reaches its maximum values for α_2- and β_1-globulins, the absolute increase is maximum for α_1-globulins. The increase of the β_2-fraction is comparatively unimportant. Glycoproteins for unirradiated rats are preponderantly in the α_1-fraction. After whole-body irradiation glycoproteins of the two α and of β_1-globulins clearly increase appropriate to the total increase. In the starch-gel electropherogram prealbumin 1 increases for the present reaching its maximum on the third day. Then it decreases slowly, whereas prealbumin 11 already disappears on the fifth day after 1000 R. The increase of α_1-globulins of the paper electropherogram is according to the results of the two-dimensional starch-gel electrophoresis based on the increase of single postalbumins and of the slow α_1-globulin. Haptoglobin belonging to the α_1-globulins decreases the course of acute radiation syndrome. The unimportant increase of β_2-globulins essen-

tially results from the increase of transferrin 11. The increased scattering of albumin values after a whole-body irradiation and the partially contradictory results of examination from the first to the third day after irradiation require a more accurate treatment. (auth)

464 RELATIVE SUSCEPTIBILITIES OF ISOTOPICALLY LABELED AND UNLABELED NUCLEI TO DEOXYRIBONUCLEASE. I. Robins, A. B. (Inst. of Cancer Research, Sutton, Eng.). Nature (London), 215: 1291-2(Sept. 16, 1967).

The use of tritiated thymidine as a specific precursor of DNA is well established in the study of DNA synthesis and the kinetics of cell population. The usefulness of the method depends on the conservation of labeled DNA and on the rapid catabolism of non-utilized nucleoside. This communication describes a study with mammalian nuclei treated with deoxyribonuclease (D Nase I) in which it was found that the labeled nucleic acid was more labile to the enzyme than unlabeled DNA. This observation may have a bearing on the use of radioactive precursors. Murine lymphoma cells of strain L 5178 Y, labeled by addition of ^{14}C-formate or tritiated thymidine, were employed in the study. It was found that the enzyme preferentially removed labeled DNA, particularly in the case of tritium labeling. Some preliminary results along similar lines have been obtained using kidney nuclei from rats treated with folate and flash-labeled with tritiated thymidine. Possible explanations of the effect are considered. (UK)

465 SERUM IMMUNOGLOBULIN IN PATIENTS WITH MALIGNANT CANCER TREATED WITH RADIOTHERAPY. Ferlazzo, B.; Minutoli, A.; Ricciardi, R. (Univ., Messina, Italy). Med. Nucl. Radiol. Lat., 9: 391-403(1966). (In Italian).

The behavior of immunoglobulin in 41 cases of malignant cancer treated with radium, ^{60}Co γ teletherapy, or x radiation was examined by immunochemical analysis. Immunoglobulins were found to be increased above normal or to maximum-normal, and in no case diminished. (auth)

466 DIGESTION OF ^{131}I-LABELED THYROID TISSUE WITH MAXIMUM RECOVERY OF ^{131}I-IODOTHYRONINES. Inoue, Kenjiro; Taurog, Alvin (Univ. of Texas, Dallas). Endocrinology, 84: 319-32(Aug. 1967).

A study was made of some of the factors responsible for the erroneously low values for ^{131}I-iodothyronines obtained when labeled thyroid homogenates are digested with pronase or pancreatin under the usual conditions of digestion. Two major sources of error were encountered: degradation of ^{131}I-iodothyronines occurring simultaneously with the release of iodoamino acids from thyroid protein, and selective adsorption of ^{131}I-iodothyronines on particulate matter that appears during digestion of thyroid homogenates with pronase. Errors from both sources were almost completely eliminated when the digestion was performed under anaerobic conditions in the presence of 0.05M methylmercaptoimidazole (MMI). Under these conditions the observed values for all the ^{131}I-iodoamino acids rose progressively as the digestion was continued for 18 hr. Not only were the 18 hr values for ^{131}I-T_4 and ^{131}I-T_3 higher than those obtained under other conditions tested, but there was better agreement between results obtained with replicate digests. On the basis of the findings reported here, we believe that pronase digestion for 16 hr under anaerobic conditions and in the presence of 0.05M MMI provides the most accurate and consistent method yet reported for releasing iodoamino acids from labeled thyroid homogenates without loss of ^{131}I-iodothyronines. (auth)

467 A METHOD FOR MEASURING PLASMA CLEARANCE OF IRON WITHOUT BLOOD SAMPLES, AND OF ESTIMATING THE EXTRAVASCULAR UPTAKE OF RADIOVITAMIN B_{12}. Hoglund, S.; Dehshiri, K.; Reizenstein, P. (King Gustaf V Research Inst., Stockholm). Phys. Med. Biol., 12: 469-76(Oct. 1967).

The use of a whole-body counter for the measurement of radioactivity in the hand and arm, following the administration of ^{59}Fe and vitamin B_{12} labelled with ^{58}Co and ^{57}Co, is described. This method can be used to follow changes in plasma level of iron. It is suggested that useful information concerning the extravascular deposition of vitamin B_{12} may also be obtained by this procedure. (auth) (UK)

468 ^{131}I RETENTION CURVES BY WHOLE-BODY COUNTER: DETECTION OF THYROID CANCER RESIDUALS. Ridings, G. Ray; Coffman, William J. (Univ. of Missouri, Columbia). Radiology, 89: 739-40(Oct. 1967).

A whole-body counter was used in measurements of retained iodine after ingestion of one microcurie of ^{131}I. Three types of curves are presented: normal thyroid retention, no apparent active retention (exponential disappearance from the body pool), and a small amount of retention (as with residual active thyroid cancer tissue). Since the whole-body counter offers a means of direct measurement, this should be a decided improvement over indirect methods of measurement, such as the urinary excretion assay. (auth)

469 EFFECT OF GAMMA RAYS ON THE ACTION OF AN ENZYME. Ebert, K. H.; Heinicke, D. (Technische Hochschule, Munich). Nature (London), 215: 1383-4(Sept. 23, 1967).

Some studies with dextransucrase are described, investigating particularly alterations in reaction rates, and specificity and structure of products. This enzyme converts sucrose into fructose and high polymer dextran. The irradiations were made with a 20,000-^{60}Co source. First results indicated that the radiation resistance of the enzyme depends to a great extent on the purity of the preparation. A plot is shown of decrease in enzyme activity vs irradiation dose. The radiation resistance of the enzyme was found to be very high; 800 kR was necessary for a 50% reduction of activity. The enzyme was completely destroyed by 2.5 MR. In all cases a decrease in reaction rate with increase in irradiation dose was observed. Mechanisms are discussed. (UK)

470 CARBOXYPEPTIDASE A. QUANTUM YIELDS ON ULTRAVIOLET IRRADIATION. Piras, Romano; Vallee, Bert L. (Harvard Medical School, Boston. Peter Bent Brigham Hospital, Boston). Biochemistry, 6: 2269-73(Aug. 11, 1967).

Ultraviolet irradiation (2537 A) inactivated carboxypeptidase A with an over-all quantum yield, Φ_{total}, of 4.9×10^{-3}. Three distinct processes were previously shown to be responsible for the inactivation of carboxypeptidase: loss of zinc, alteration of a tyrosine at the active center, and changes in structure resulting in denaturation. The quantum yields of destruction for each of these processes were determined and were 1.6×10^{-3}, 5×10^{-4}, and 2.8×10^{-3}, respectively. Quantum yield was smaller than the value predicted, confirming that only some of the absorbing amino acids were essential for activity. Comparison of the individual quantum yields obtained with those calculated showed that the quantum yield of inactivation of an enzyme can only be predicted exactly when the nature and number of amino acid residues directly or indirectly involved in enzymatic activity can be established. (auth)

471 DETECTION OF RADIATION DAMAGE IN EXPOSED PERSONNEL BY CHROMOSOME STUDY. El-Alfi, Omar S.; Ragab, Abdel Salam; Eassa, Eassa-Helmy M. (Cairo Univ.). Brit. J. Radiol., 40: 760-4(Oct. 1967).

Personnel exposed to β,γ, neutron, and x radiation were studied for evidence of chromosome damage by peripheral blood counts and by leucocyte cultures. In some of them the leucocyte counts were normal while the chromosomes showed definite damage, thus emphasizing the importance of chromosome study as a periodic test in radiation-exposed personnel. (auth)

472 COATED CHARCOAL ASSAY OF PLASMA IRON BINDING CAPACITY AND IRON USING RADIOISOTOPE DILUTION AND HEMOGLOBIN-COATED CHARCOAL. Herbert, Victor; Gottlieb, Chester W.; Lau, Kam-seng; Gevirtz, Norman R.; Sharney, Lena; Wasserman, Louis R. (New York Univ., N. Y.). J. Nucl. Med., 8: 529-41(July 1967).

Using radioisotope dilution, and hemoglobin-coated charcoal for batch separation, plasma ^{59}Fe may be measured. From 0.5 ml of plasma, native transferrin-bound iron is released at pH 5.8 (by adding 0.5 ml of pH 5.3 buffer to the plasma), following which 3 μg $^{59}FeCl_3$ is added. After subsequent addition of buffer to raise the pH to 7.4 and thus allow rebinding of a portion of the pool of radiodiluted iron by transferrin, iron-transferrin complex is separated from excess free iron by hemoglobin-coated charcoal and the plasma iron level computed by an appropriate formula. This method provides a model for the assay of similar constituents in biologic fluids, in which the binder for the agent is naturally present in the fluid under assay. (auth)

473 ROLE OF THE ALLOSTERIC SITES IN THE X-RAY INACTIVATION OF PHOSPHORYLASE b. Damjanovich, S.; Sanner, T.; Pihl, A. (Norsk Hydro's Inst. for Cancer Research, Montebello, Norway). Eur. J. Biochem., 1: 347-52(May 16, 1967).

Crystalline rabbit muscle phosphorylase b was x irradiated in dilute aqueous solution. The enzyme was inactivated with a G value of 0.09. Measurements of the K_m values of the substrate, glucose-1-phosphate, and the allosteric activator, adenosine-5′-phosphate, demonstrated that these increased linearly with increasing radiation dose. The effect on the K_m for the activator was 4 times greater than that on the K_m for the substrate. The data indicated that the allosteric function is more sensitive to inactivation than the catalytic function. The enzyme SH-groups were destroyed by x rays with a G value of 1.8. Comparison with data on the inactivation of the enzyme by sulfhydryl blocking agents demonstrated that the x-ray destruction of sulfhydryl groups was sufficiently

large to account for the x-ray inactivation of the enzyme. Blocking of 2 SH-groups with p-chloromercuribenzoate (pCMB) reduced the radiosensitivity of the enzyme by a factor of 2. Measurement of the K_m values showed that the pCMB blocking protected preferentially all allosteric sites. The data indicate that the inactivation of phosphorylase b, both by sulfhydryl agents and by x rays, involves largely an effect on the allosteric sites with loss of ability to bind the essential activator and consequent loss of ability to bind substrate. (BBB)

Ecology

474 POSSIBLE ROUTES OF ^{65}Zn FROM AN EXPERIMENTAL ESTUARINE ENVIRONMENT TO MAN. Duke, Thomas W. (Bureau of Commercial Fisheries Radiobiological Lab., Beaufort, N. C.). J. Water Pollut. Contr. Fed., 39: 536-42(Apr. 1967).

Zinc-65 occurs in estuarine environments as fallout from nuclear detonations and as wastes from nuclear reactors. It is concentrated by organisms used as seafood by man and by organisms that serve as food for seafood species. Therefore, the movement of ^{65}Zn in the estaurine environment was studied to determine the routes and rates by which it could be returned to man and the organisms that could be used as indicators of the presence of ^{65}Zn in this environment. It was shown that <1% of the ^{65}Zn introduced into the water of a pond was accumulated by seafood organisms. Loss of ^{65}Zn from the pond through the exchange of pond water with water in the adjoining estuary and absorption of the isotope by sediments greatly affected the accumulation of the isotope by the biota. Shellfish accumulated the isotope rapidly and to higher levels than did other organisms, and the ^{65}Zn accumulated in the edible portions of these animals easily could have been transferred to man. If all organisms from the pond were eaten by man over a long period of time he could have accumulated more ^{65}Zn from clams than other organisms because edible portions of the clams had the highest specific activity. The meats of oysters contained highest levels and the oysters could have been a potential hazard. Scallops were good indicators of the presence of ^{65}Zn if samples were taken one day after the isotope was added to the water. Oysters, however, retained the ^{65}Zn longer than did scallops and after 100 days contained more of the isotope on a whole-animal basis. (BBB)

Genetics and Cytogenetics

475 (UCLA-34P8-15) MUTATION STUDIES OF HISTOCOMPATIBILITY GENES IN MICE. [Progress Report]. [Bailey, Donald W.] (California Univ., San Francisco. Medical Center). June 30, 1967. Contract AT(11-1)-34, 23p. Dep. CFSTI.

Progress is reported on studies on the induction of mutations of histocompatibility (H) genes in mice and the analysis of H mutations with respect to independence, type of change, severity of change, and mapping in the genome. Paternal x irradiation at the dose and dose rate applied had no effect on mutation frequency, indicating that H genes are resistant to acute x irradiation. The procedure used for developing cogenic mouse lines that carry distinctive H alleles is outlined. Criterial by which mutant H genes can be characterized are described. (C.H.)

476 A COMPARATIVE STUDY OF THE EFFECT OF UV RADIATION AND DIETHYLSULFATE VAPOURS ON MICROCOCCUS GLUTAMICUS. A GLUTAMIC ACID PRODUCING MICROORGANISM. Zhdanova, N. I.; Arakelova, V. A. (Kurchatov Inst. of Atomic Energy, Moscow). Genetika, No. 8, 89-95 (Aug. 1967). (In Russian).

It was shown by the comparison of the effects of the two mutagenic factors on a number of Micrococcus glutamicus strains producing L-glutamic acid, that diethylsulfate vapours induce a considerable variability with respect to morphological characters and glutamic acid producing capacity. Ultraviolet radiation induce but a slight variation of these characters. The mutability of some mutant strains of M. glutamicus differs from that of the initial strain. (auth)

477 THE SIZE DISTRIBUTION OF X-RAY INDUCED MULTILOCUS DELETIONS IN THE ad-3 REGION OF NEUROSPORA CRASSA. De Serres, F. J.; Webber, B. B. (Oak Ridge National Lab., Tenn.). Genetics, 57: 449-54(Oct. 1967).

The genotypes of x-radioinduced ad-3 mutations resulting from multilocus deletion (irreparable ad-3 mutations—ad-3^{IR}) in a two-component heterokaryon were considered in relation to the map distances between genetic markers near the ad-3 region on linkage group I. The discrepancy between the ratio of the different genotypes expected and that observed was attributed to a decreasing probability for two independent chromosome breaks to fuse and produce a chromosome deletion as the distance between them increased. (auth)

478 HANDLING IRRADIATED MATERIAL IN SEGREGATING GENERATIONS. Goud, J. V. (Univ. of Agricultural Sciences, Bangalore, India). Curr. Sci. (India), 36: 557-8(Oct. 20, 1967).

The effects of gamma radiation on seeds of a hexaploid variety of wheat were studied. The first four tillers were separated from the others and the M_2 progenies were grown keeping the main tiller and side tiller progenies separately. Chlorophyll and viability mutation frequencies were determined and results are tabulated. Mutation frequencies were greater in the main tiller progeny. It was concluded that separation of 5 to 6 primary tillers and raising the M_2 generation as M_1 spike progeny would be much more advantageous than growing M_1 plant progenies in crops such as wheat. (H.L.W.)

479 GAMMA-RAY-INDUCED MUTANTS IN A JAPANESE VARIETY OF COMMON WHEAT. Ichikawa, Sadao; Nishiyama, Ichizo (Kyoto Univ.). Nippon Idengaku Zasshi, 42: 175-87 (June 1967).

Dry seeds of a Japanese variety of common wheat (6x), Shinchunaga, were irradiated with 10 to 40 kR of gamma rays from ^{60}Co. No chlorophyll mutations were detected, while various kinds of morphological mutants were found in the X_2 through X_4 generations. About one third of the morphological mutants were found in the X_2, another third in the X_3, and the remaining third in the later generations. The lack of any chlorophyll mutation and the frequent occurrence of various morphological mutations are considered to indicate that there is a difference in the extent of differentiation in this polyploid plant between essential genes such as those for chlorophyll production and non-essential genes such as those determining spike length or density. Many speltoid, compactoid, squareheaded, lax-spiked and dense-spiked mutants were found, as well as various other mutants. Cytogenetical investigations revealed that most of these morphological mutants were caused by various chromosomal aberrations, such as deficiencies, telecentrics, isochromosomes, and various aneuploid constitutions. (auth)

480 IDENTIFICATION OF THE CHROMOSOMES CONTROLLING GAMMA-RAY-INDUCED MUTANT CHARACTERS IN A JAPANESE VARIETY OF COMMON WHEAT. Ichikawa, Sadao (Kyoto Univ.). Nippon Idengaku Zasshi, 42: 189-94 (June 1967).

Identifications of the chromosomes controlling mutant characters were carried out on twelve different strains of gamma-ray-induced mutants of Shinchunaga wheat, utilizing the monosomic and ditelosomic series of Chinese Spring. Speltoid mutants were due to the loss of a part or the whole of the long arm of chromosome 5A, or due to the loss of the whole chromosome. Compactoid-squareheaded mutants were caused by duplications or increased dosages of the long arm or the whole of this chromosome. Squareheaded mutants having no relationship with compactoids were induced by the loss of the short arm of the same chromosome. Lax-spiked mutants were the result of the nullisomic condition of chromosome 6D or of the loss of one of the 6D arms. It was found that, in Shinchunaga, tri-5A, tetra-5A complements produce squareheaded, subcompactoid and compactoid mutants, respectively, whereas, in Chinese Spring, tri-5A and tetra-5A yield subcompactoid and compactoid plants, respectively (Table 1). Mutants implicating chromosome 5A were much more frequently detected than those involving any other chromosomes. However, it is concluded that this result does not indicate any particular high radiosensitivity of this chromosome but it only reflects the fact that this chromosome carries a few genes which loss results in striking phenotypic changes even in hetero- or hemizygous conditions, thus, mutants involving this chromosome were more easily detected. (auth)

481 THE EFFECT OF DIFFERENT TYPES OF IONIZING RADIATIONS ON THE INITIATION OF CHROMOSOME ABERRATIONS IN PEA. III. RELATIVE BIOLOGICAL EFFICIENCY (RBE) OF HIGH-ENERGY PROTONS AND ^{60}Co GAMMA RAYS IN THE INDUCTION OF CHROMOSOMAL ABERRATIONS. Akopyan, E. M. (Inst. of Medical Radiology, Obninsk, USSR). Genetika, No. 8, 49-52(Aug. 1967). (In Russian).

Air-dry pea seeds were irradiated by 630 MeV protons at a dose range of 1.5 to 40 krad and by ^{60}Co gamma rays at dose rates 4,200, 700, and 70 rad per min. In consequence of the high efficiency of proton irradiation, a precise determination of the frequency of induced chromosome fragments and bridges was possible only at doses below 10 krad and 20 krad respectively. At the latter dose of irradiation by protons practically all the cells were damaged and the number of such aberrations per nucleus became very great. For the determination of the RBE of protons, the dose-effect curves for chromosome fragments and bridges and for the fre-

quency of damaged cells obtained at gamma dose rates of 4.200, 700, and 70 rad per min were compared. The frequencies of fragments and bridges at these dose rates were 2.3, 3.6, and 5.5, and the percentages of damaged cells were 4.3, 5.2 and 6.9 respectively. (auth)

482 INDUCTION OF MUTATIONS IN WHEAT. I. EFFECTS OF X RAYS, GAMMA RAYS, AND FAST NEUTRONS ON THE FREQUENCY AND TYPE OF CHROMOSOMAL ABERRATIONS IN THE MITOSIS AND ON THE INITIAL GROWTH OF PLANTS IN SOME VARIETIES OF DURUM AND BREAD WHEATS. Chavdarov, G. A.; Dzhelepov, K. P. (Research Inst. of Wheat and Sunflower Breeding, Tolbukhin, Bulgaria). Genetika, No. 8, 18-29(Aug. 1967). (In Russian).

The effects of increasing doses of x rays, gamma rays, and fast neutrons on the frequency and the type of chromosome aberrations in mitosis and on initial growth in different varieties of wheat were studied. A positive correlation with radiation dose was established for chromosomal aberrations and a negative one for the length of seedlings for the three types of radiation for the number of rootlets and their total length in the material irradiated by x rays and gamma rays, and for germination in the field after irradiation by gamma rays. X rays doses below 20 kR, gamma rays doses below 10 kR, and fast neutron doses below 640 rad did not affect significantly the capacity of germination under the laboratory conditions in most varieties. In the material irradiated by x rays the dependence between the dose and the frequency of chromosomal aberrations was linear in character, and exponential in that irradiated by gamma rays, while for fast neutrons the dose-effect curve was a part of an elliptical curve. It was impossible to determine for all the species and varieties of wheat a single definite and invariable type of functional dependence of the frequency and the type of chromosomal aberrations on the type and dose of radiations. The responses to different types of radiations varied from variety to variety and the authors failed to draw a decisive conclusion about the tendency to a relatively lower radiosensitivity in durum wheat. This means that the number of genomes is less important than their genotypic composition. The relative biological efficiency of gamma rays was 2 to 3 times and of fast neutrons was 4 to 6 times that of x rays for different characters in different varieties. (auth)

483 NATURE OF THE LETHAL AND MUTAGENIC ACTION OF ULTRAVIOLET LIGHT ON FROZEN BACTERIA. Bridges, B. A.; Ashwood-Smith, M. J.; Munson, R. J. (Medical Research Council, Harwell, Eng.). Proc. Roy. Soc. (London), Ser. B, 168: 203-15(Aug. 15, 1967).

The supersensitivity of bacteria to ultraviolet light when irradiated at low temperatures in frozen suspension was studied in relation to known cellular mechanisms for repair of radiation damage. Strains of Escherichia coli deficient in such mechanisms, and hence more sensitive to the lethal action of uv, showed little or no additional supersensitivity, however, at −79°C. The deficiencies studied were in hcr locus controlling ability to excise pyrimidine dimers from DNA; fil locus, probably acting at least in part by permitting more effective use of the excision-repair system; rec locus, controlling an aspect of the ability to undergo recombination, presumably by action of DNA, conferring x-ray resistance; exr locus, controlling ability to repair x-ray damage, possibly by rejoining single-strand breaks. It was concluded that damage induced by uv at −79°C differs from that induced at 22°C in being much less amenable to repair by the systems acting on DNA than damage induced in the non-frozen state. Supersensitivity of the reactivation systems themselves at −79°C was excluded (unless the reactivation system and the DNA are both inactivated by the same absorption event). Mutational damage induced by uv at −79°C differed from that induced at 22°C in that the observed mutation frequency was less dependent upon immediate post-irradiation protein synthesis. Furthermore, such damage was not involved in the cumulative (dose-squared) response when bacteria were thawed and irradiated further at 22°C. The observation of Smith that the cross-linking of DNA with protein is greater when exposure to uv is carried out at −79°C than at room temperature was confirmed. (auth) (UK)

484 RADIOGENETIC INVESTIGATION OF MAN. RADIOSENSITIVITY OF HUMAN CHROMOSOMES IN LEUCOCYTE CULTURE OF PERIPHERAL BLOOD. Gol'dman, I. L.; Iofa, E. L. (Inst. of General Genetics, Moscow). Genetika, No. 8, 115-25(Aug. 1967). (In Russian).

The radiosensitivity of human chromosomes in lymphocytes cultivated in vitro and x irradiated at the different phases of the cell cycle was investigated. An increased radiosensitivity of G_2 phase was observed. (auth)

485 THE INFLUENCE OF THE GENOTYPE ON THE FREQUENCY OF RADIATION-INDUCED ANEUPLOIDY IN THE OOGENESIS OF DROSOPHILA MELANOGASTER. I. RING X-CHROMOSOME. Glotov, N. V.; Sushkin, A. G. (Inst. of Medical Radiology, Obninsk, USSR). Genetika, No. 8, 60-4(Aug. 1967). (In Russian).

In the opening communication of this series of studies concerning the influence of the genotype on the frequency of radiation-induced aneuploidy in the oogenesis of Drosophila melanogaster the dose-response curves are compared for normal and X-ring strains. In the progeny of the normal (i.e., with telomeric X) yellow-strain females the spontaneous frequencies of XXY-females and XO males were 0.22% and 0.36%, respectively, while in the progeny of females of the X-ring strain (X^c, y v) the corresponding frequencies were 0.03% and 0.12% respectively. Two-day-old females were irradiated by ^{60}Co gamma rays (doses of 1, 2, 3, 4, and 5 kh) and mated immediately to Berlin wild males. The progeny of the first three days of egg deposition was scored. Dose-response curves for both strains studied coincided well (the control being subtracted) and were in good agreement with the results obtained by Traut [Mut. Res. 1: 157(1964)]. The lower frequency of XO-males in the progeny of irradiated X^c, y v females might be due to the lower frequency of chromosome aberrations in females [Glass, Genetics 40: 252, 281 (1955)], as well as to the relatively lower sensitivity of the method used, as compared to the calculation of females : males ratio. (auth)

Health Physics and Safety

Refer also to abstracts 181, 375, 423, 546, 1287, and 1914.

486 (AD-631989) RADIATION MONITORING WITH NUCLEAR EMULSIONS ON PROJECT GEMINI. I. EXPERIMENTAL DESIGN AND EVALUATION PROCEDURES: PARTIAL RESULTS ON MISSIONS 4 AND 5. Schaefer, Hermann J.; Sullivan, Jeremiah J. (Naval Aerospace Medical Inst., Pensacola, Fla. National Aeronautics and Space Administration, Houston, Tex. Manned Spacecraft Center). Feb. 18, 1966. 16p. (NAMI-955). CFSTI.

On Gemini four and five, small packs of nuclear emulsions combined with other radiation sensors to flat pliable units were worn by the astronauts inside their space suits. Track and grain counting of 200 micra Ilford G.5 and K.2 emulsion pairs in the packs furnished the particle and energy spectrum of the radiation incident upon the astronaut's body. Evaluation of flux and energy spectrum in terms of millirad dose showed that the bulk of the exposure was due to trapped protons picked up in the South Atlantic Anomaly. The energy spectrum of the proton flux within the ship on the body of the astronaut is a continuum extending from zero to about 300 Mev, with a broad, well-developed maximum in the 30 to 40 Mev region. Because of the large fractional flux of low energy particles, the radiation level sensitivity depends on local shield geometry producing variations of dose rate at different locations in the capsule of at least 60 per cent. Representative total doses were 48 millirads on Gemini four and 105 millirads on Gemini five. (auth) (TAB)

487 (AD-634608) NOTE ON THE DOSIMETRIC INTERPRETATION OF RIGIDITY SPECTRA FOR SOLAR PARTICLE BEAMS. Schaefer, Hermann J. (Naval Aerospace Medical Inst., Pensacola, Fla.). Apr. 26, 1966. Contract NASA Order-75. 17p. (NAMI-960). CFSTI.

By using the experimental rigidity formulation as proposed by Freier and Webber, the particle fluxes of all flare events of the past solar cycle can be uniformly described in terms of a flux constant J_0 and a rigidity constant P_0. On the basis of these data, three fictitious rigidity spectra are synthesized covering the full variability range of all flare events, yet characterizing more systematically the relationships between the basic dosimetric quantities and the rigidity constant P_0. It is found that, of the components heavier than protons, only alpha particles contribute substantially to total exposure. The fractional alpha dose in the tissue surface behind 0.1 $g/^2cm$ shielding grows from 40 percent for P_0 = 50 Mv to 400% for P_0 = 300 Mv. At the same time, the depth dose of the alpha component shows an extremely steep drop that would require microsensors for accurate measurement. For the alpha and medium heavy components, the RBE shows a pronounced transition in near surface regions that further steepens the drop of the RBE dose equivalents as compared to the rad doses. The extremely strong and nonlinear dependence of the rad and rem dose distribution on rigidity makes the rigidity concept practically useless for any dosimetric evaluation and indicates the need for direct measurements of local rad and rem doses on the astronaut's body. (auth) (TAB)

488 (AEEW-M-715) A COMPARISON OF THE PREDICTED AND OBSERVED LOW-ENERGY RADIATION FROM THE THORAX OF A NORMAL HUMAN MALE. Speight, R. G. (Atomic Energy Establishment, Winfrith (England)). July 1967. 7p. Dep. CFSTI. UK 1s. 6d.

The normal human male emits a continuum of low energy photons (< 100 keV) whose magnitude depends on the body content of ^{40}K and ^{137}Cs and the physical parameters of the body. An experiment is described which enables the level of this continuum to be predicted within an accuracy of ±6 per cent. A thin NaI(Tl) crystal was used to monitor the 27 to 78 keV band from the thorax. (auth)

489 (BNWL-SA-1420) INTRODUCTORY TALK IN PANEL DISCUSSION ON BIOLOGICAL EFFECTS OF FALLOUT. Kornberg, H. A. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Sept. 15, 1967. Contract AT(45-1)-1830. 8p. (CONF-670939-1). Dep. CFSTI.

From 5th World Congress of Gynaecology and Obstetrics, Sydney, Australia.

The biological effects of fallout are reviewed. It is pointed out that when the Pu or U atom is split, energy and fission products are formed. Fission products are comprised of more than 200 isotopes of 35 elements. Most of the isotopes are radioactive and very short lived so that rapid diminution of radioactivity occurs immediately after their formation. A number of the longer-lived radioisotopes may be present in fallout, but only six are of special biological significance and the relative hazard indices (RHI) of these change with time since they decay at different rates. The large amount of ^{131}I initially formed by a nuclear explosion is most important soon after the test but as time elapses ^{90}Sr increases in relative importance. Weapons tests have injected Pu into the atmosphere, and it may enter humans as a result of inhaling or ingesting fallout. The remaining radioisotopes high on the relative hazard index are radioisotopes of Cs, I, and Sr, which may pass through the food chain to man and deposit in the soft tissues, thyroid, and bone, respectively, where sufficiently high doses may cause genetic changes, thyroid cancer, bone sarcoma, and leukemia. World-wide measurement of the content of these radioisotopes in the atmosphere, food, and man show that during a peak year, 1963, fallout delivered less than 10 mrad to the average man, while the average radiation dose from natural background radiation was about 100 mrads/yr to the average individual. It is pointed out that the Federal Radiation Council has recommended limits of radiation exposure applicable to the individual and to the population at large to reduce risks to both individuals and future populations. (C.H.)

490 (CONF-660649) GEMEINSAME TAGUNG UEBER ERFAHRUNGEN BEI DER ANWENDUNG VON STRAHLENSCHUTZREGELUNGEN IN KERNTECHNIK UND INDUSTRIE, VOM 1.-3. JUNI 1966 IN DER KERNFORSCHUNGSANLAGE JUELICH. (Joint Meeting on Experience in the Use of Radiation Protection Rules in Nuclear Technology and Industry, June 1-3, 1966 in the Juelich Nuclear Research Center). (Societe Europeenne de Protection Contre les Rayonnements). Sept, 1966. 237p. (In German). Dep.

Twenty-seven papers discuss regulations of European countries regarding radiation protection in industries, research installations, and laboratories using radioisotopes and radiation sources and at cyclotron sites. Topics discussed include maximum permissible radiation doses; waste disposal; licensing procedures; cost factors involved in radiation protection; requirements for personal dosimeters and their reliability for legally required radiation protection measurements; problems in calibration of radiation dosimeters; the measurement of radiation fields; the monitoring of sealed radiation sources; special problems of industries using radioactive materials and radiation sources; the handling of contamination incidents by industry; and international cooperation for radiation protection. (C.H.)

491 (KY-543) ENVIRONMENTAL MONITORING SUMMARY FOR THE PADUCAH PLANT FOR 1965 AND 1966. Baker, R. C.; Davis, K. A. (Paducah Gaseous Diffusion Plant, Ky.). Sept. 1, 1967. Contract W-7405-eng-26. 11p. Dep. CFSTI.

Outdoor monitoring of air, water and vegetation in the vicinity of the Paducah Plant is summarized for the years of 1965-1966. (auth)

492 (LA-3731) LASER SAFETY PROGRAM. Ehrenkranz, T. E.; Ettinger, H. J. (Los Alamos Scientific Lab., N. Mex.). July 1967. Contract W-7405-eng-36. 20p. Dep. CFSTI.

A safety program that was compiled and issued to show how a simple, direct safety program for the use of lasers can be developed is presented. The program consists of excerpts from the LASL Health and Safety Manual, memoranda depicting the activities of the safety and industrial hygiene personnel of the USAEC, and three tables: laser safety recommendation, exposure thresholds, and literature references (15). (B.H.S.)

493 (NYO-2753-5) ^{90}Sr LEVELS IN THE DIETS AND BONES OF CHILDREN. Progress Report, 1967. (Comision Nacional de Energia Atomica, Buenos Aires (Argentina)). [June 2, 1967]. Contract AT(30-1)-2753. 47p. Dep. CFSTI.

Discrimination studies were made on ^{90}Sr and natural Sr in bones of children. Values at various ages and correlations with diet levels are tabulated. Strontium to calcium ratios in the total diet are included. Intakes of natural Sr were derived from diet composition and measurements of Sr/Ca in food items. The turnover rate was found to be very fast shortly after birth, decreasing almost exponentially to an annual value of about 10% in the second year. An additional increase in turnover occurred in the 6 to 8 and 8 to 10 year age groups. Turnover decreased in the 10 to 12 year age group to less than 10% per year. The discrimination factor between strontium and calcium varied from about 0.7 in the first months of life to about 0.3 in the second year of life, and was substantially constant between the 4th and 12th years, approaching the adult value of 0.25. Routine measurements of ^{226}Ra in bone and diet were made, and radium to calcium ratios were determined. (H.L.W.)

494 (NYO-3364-29) ^{137}Cs IN POTATOES IN NORWAY, FALL 1964 AND FALL 1965. Madshus, Kjell (Norsk Hydro's Inst. for Cancer Research, Oslo); Stroemme, Aksel (Norsk Radium Hospital, Oslo); Koren, Kristian (Statens Radiologisk-Fysiske Laboratorium, Oslo (Norway)). Contract AT(30-1)-3364. 7p. Dep. CFSTI.

Samples of potatoes grown in Norway were analyzed for ^{137}Cs by means of γ-spectrophotometry. The average concentration of ^{137}Cs in each county, each zone, and in the whole of Norway are presented in tabular form. The ^{137}Cs content of potatoes from the various districts showed a similar geographical distribution to that found in meat and milk, but differences between the content in the three designated zones were more pronounced. Also, the average content of ^{137}Cs (5μCi) in all zones showed a marked decrease from fall 1964 to fall 1965; only samples from seven countries showed an increase. This marked decrease seemed to indicate that the ^{137}Cs from the atmosphere that is directly deposited on the green parts of the plant was more important for uptake by the plant than the ^{137}Cs in the soil. There was no correlation between the content of ^{137}Cs in potatoes and the height above sea level or distance from the sea of the districts where they were grown. It was also found that only a minor part of the ^{137}Cs in the potatoes was extracted when they were prepared for eating by boiling. (B.H.S.)

495 (UCLA-12-654) RADIOLOGICAL SOIL ANALYSIS: PACIFIC, NOVEMBER 1952. Mork, Harold M. (California Univ., Los Angeles. Lab. of Nuclear Medicine and Radiation Biology). Sept. 1967. Contract AT(04-1)-Gen-12. 23p. Dep. CFSTI.

Soil samples were collected from several Pacific Islands in Eniwetok Atoll in November, 1952 by Lauren R. Donaldson and his group from the University of Washington Applied Fisheries Laboratory. Microscopic and radiological examination revealed that the contamination of the soil was not present as discrete particulate material that could be isolated, but rather was adsorbed on or occluded in the soil particles in all size fractions. Further analysis with an ion exchange resin column indicated that the specific radioisotopes present in the soil included those radioisotopes normally occurring in fallout of continental origin. Some induced activity may have been present. (auth)

496 (UCRL-50163(Pt.3)) PREDICTION OF THE MAXIMUM DOSAGE TO MAN FROM THE FALLOUT OF NUCLEAR DEVICES. III. BIOLOGICAL GUIDELINES FOR DEVICE DESIGN. Burton, C. Ann; Pratt, Michael W. (California Univ., Livermore. Lawrence Radiation Lab.). July 25, 1967. Contract W-7405-eng-48. 17p. Dep. CFSTI.

A method has been developed to estimate the biological hazard due to the radioisotopes that result from reactions between nuclear device components and the particles released by the device. This method can be used in preshot rad-safe analysis, as guidance for postshot documentation, and in the choice of the most biologically suitable elements for device design. As an example of the technique, tungsten was studied in detail. It was found that, in tungsten, the charged-particle reaction products may be the largest contributors to the biological hazard from this element. (auth)

497 (UCRL-70608) RADIOLOGICAL HEALTH ASPECTS IN UNDERGROUND NUCLEAR TESTING. King, W. C. (California Univ., Livermore. Lawrence Radiation Lab.). Sept. 15, 1967. Contract W-7405-eng-48. 21p. (CONF-670944-1). Dep. CFSTI.

From 11th Annual Western Industrial Health Conference, San Francisco, Calif.

The methods used by LRL for monitoring and documenting the unplanned release of radioactive material following a nuclear

detonation have proved reliable and efficient. Estimates of releases can be made within minutes after the release, and are well within the factor-of-ten accuracy required by the Test Manager. (auth)

498 (NP-tr-1575) DOSIMETRIC AND RADIOBIOLOGICAL EXPERIMENTS WITH FAST NEUTRONS. [PART] I. Zimmer, K. G. Translated by O. S. Whitston (Atomic Energy Research Establishment, Harwell, Eng.), from Strahlentherapie, 63: 517-27(1938). 18p. Dep. CFSTI. JCL $1.60 fs, $0.80 mf.

The adaptation of a small tissue-equivalent ionization chamber for use in fast neutron dosimetry is described. Fundamental principles and fundamental testing of the method are discussed. (C.H.)

499 REGULATIONS FOR PROTECTION AGAINST INJURIES CAUSED BY IONIZING RADIATIONS IN SCHOOLS. (2nd REGULATION ON RADIATION PROTECTION). Krempien, J. (Medizinisch-Technische Assistenten, Berlin). Roentgenpraxis, 18: 257-60(Nov. 1965). (In German).

The author briefly summarizes and discusses regulations put into effect on 10/1/64 for protection against irradiation from devices and equipments used in universities and medical schools. These include definition of the scope and application of the regulations; use, installation, removal, and transfer of radioactive materials; operation of x-ray equipment, and neutron sources; approval of construction of installations that contain radioactive materials, neutron sources, and x-ray equipment; protective measures for installation, use, and operation of measurement equipment, neutron sources, and x ray devices; responsibilities for radiation protection; and procedures for application of the regulations. (BBB)

500 ^{54}Mn CONTAMINATION OF THE SEA. Calapaj, G. G. (Univ., Padua). Acta Isotop., 6: 253-9(Dec. 15, 1966). (In Italian).

Two years experiences led to the conclusion that among marine organisms Pinna nobilis is the most effective accumulator of ^{54}Mn, because of its ability to accumulate stable Mn. Chlamis varia and sinuosa, though to a lesser extent, show the same characteristics. Therefore Pinna nobilis could be considered as critical organism, in the sense of radioprotection for ^{54}Mn in all cases in which this radioisotope can be considered as critical radionuclide for a certain type of nuclear plant.

501 REGULATIONS AND CONTROL FOR RADIATION PROTECTION. Voss, Milo D. (Ames Lab., Iowa). Trans. ASAE (Amer. Soc. Agr. Eng.), 9: 421-3; 427(1966).

Protection against personnel exposure, particularly in laboratories using radioisotopes, is reviewed. Actions that should be taken to assure radiological safety are discussed. (BBB) (TSS)

502 A PILOT PLANT FOR THE REMOVAL OF RADIOACTIVE STRONTIUM FROM MILK: AN INTERIM REPORT. Glascock, R. F. (National Inst. for Research in Dairying, Reading, Eng.). J. Soc. Dairy Technol., 18: 211-17(1965).

A pilot plant process was developed for extracting ^{90}Sr from milk on the basis of an ion exchange method. The one-tenth scale plant had a capacity of 500 gal/day. The resin used was Zeocarb 225, 14-52 mesh. The objective was that of removing at least 90% of the ^{90}Sr or of achieving a 10-fold reduction in the activity present. The efficiency of removal gradually decreased as the process proceeded and no more than 30 bed volumes of milk could be treated if the average efficiency was not to fall below 90%. The composition of the regenerating solution was such that Ca, Na, K, and Mg were in the same ratio as in milk. Although the process was mainly concerned with the removal of ^{90}Sr, it was found that other radioactive cations such as ^{137}Cs and ^{140}Ba could be removed. Efficiency of removal of ^{140}Ba was determined to be about the same as that of ^{90}Sr, but because the affinity of the resin was not the same for monovalent and divalent ions, the efficiency of removal of ^{137}Cs would be less; ^{131}I was not affected by the resin. (BBB)

503 COUNTING EMISSIONS FROM ^{42}K IN PLANT TISSUE WITH A LIQUID SCINTILLATION SPECTROMETER. Nuttall, W. F.; Carter, A. L.; Warkentin, B. P. (McGill Univ., Quebec, Can.). Plant Soil, 26: 385-8(Apr. 1967).

A method was devised to count emissions from ^{42}K in plant tissue by liquid scintillation spectrometry with low quenching. The plant samples were ashed in Al dishes, folded into Al wafers, and suspended in the liquid scintillator of counting vials. The samples were counted in a scintillation spectrometer at 1- to 5-min intervals 7 or more times and until the total exceeded 1000 counts. The efficiency of counting was ~70%. A computer program was written to calculate decay corrections for the short half-life isotope ^{42}K. The program computed the weighted mean of the counts, standard deviation of the mean, percentage standard deviation of the mean, and Chi-square value for each sample. The measurements were precise enough for ^{42}K uptake studies. (BBB)

504 IODINE-131 IN FOODS. Straub, C. P.; Murthy, G. K.; Campbell, J. E. (Robert A. Taft Sanitary Engineering Center, Cincinnati). Residue Rev., 13: 33-68(1966).

The following aspects of radioiodine contamination of foods are reviewed; sources of production, forms of ^{131}I, biological transport mechanisms, entry into food chain and metabolism, sampling and sampling techniques in milk, vegetation, and other environmental samples, nature of ^{131}I in milk, concentration in milk, methods for determining ^{131}I in milk, protection guides and regulations, and countermeasures. The chemical nature of radioiodine in fallout was identified as iodide ion plus iodine, and iodate ion, and small amounts of periodate ion. When deposited on plants, ^{131}I is absorbed through leaves but not translocated into other plant parts, and there is no root uptake. It is concentrated in the thyroid gland; excretion may be through several routes including milk. Radioiodine is present in milk mostly in the inorganic form as the iodide, very little being bound by proteins. In countries where it is abundant, milk is considered as the major dietary source of ^{131}I to children, whereas in countries where milk is a luxury, leafy vegetables may form a major source of intake. The marked differences in the concentration of ^{131}I in milk produced in different parts of the world are attributed mainly to the geographical location of the milkshed in relation to weapons testing sites and the meteorological and climatological factors. Various techniques to reduce ^{131}I levels in milk include moving of cows from pasture to barn and feeding them uncontaminated food, and the removal of ^{131}I from milk by commercially feasible ion-exchange techniques. (BBB)

505 THE ^{90}Sr ACTIVITY OF MILK IN 1964. Seidler, H.; Haertig, M. (Institut fuer Ernaehrung, Potsdam-Rehbruecke, Ger.). Nahrung, 9: 701-3(1965). (In German).

The ^{90}Sr activity in local milk samples and in fallout samples was measured and compared for calendar yr 1964. Over-all, the average values of fallout and atmospheric activities reached their max during the spring and early summer. These amounted to ~20 nCi/m^2 and ~3.5 pCi/m^3, respectively. Compared to the previous yr, the ^{90}Sr activity was slightly higher in 1964, but the 1964 weekly values almost all were at the level of monthly average, whereas in July and August, 1963, single max values reached as high as 60 pCi ^{90}Sr/g Ca. From the large decreases in the fallout and atmospheric activities observed from May, 1964, on and the decreased levels of single values it can be concluded that in 1964 the ^{90}Sr contamination of milk reached and exceeded the max contamination observed after the last series of nuclear weapons tests in October, 1961. In 1964 the annual mean of the ^{90}Sr activity of milk amounted to 10.5 pCi ^{90}Sr/g Ca. (BBB)

506 TRANSFER OF FALLOUT ^{54}Mn FROM FEED TO MILK. Wilson, D. W.; Ward, Gerald M. (Colorado State Univ., Fort Collins). J. Dairy Sci., 50: 592-3(Apr. 1967).

Manganese-54, a γ-emitting neutron activation product with a half-life of 310 days, was regularly observed since May, 1963, in fallout-contaminated dairy feeds, and in rainfall and surface air. The transfer coefficient for the transfer of ^{54}Mn from an alfalfa hay diet to milk was $\sim 7 \times 10^{-6}$ per liter, while for fallout ^{137}Cs transfer coefficients were $\sim 4 \times 10^{-3}$ per liter. The transfer coefficient is defined as the daily intake of the radioisotope in feed in pCi, divided by the resulting concentration of the radioisotope in milk (pCi per liter). The rate of secretion of ^{54}Mn into milk is extremely low, due to poor absorption from the gut. Manganese-54 was not found in muscle tissue of dairy cattle, but was in the liver of several slaughtered cows at levels of 30 to 341 pCi/Kg of wet tissue, comparable to the usual ^{137}Cs levels. It was not observed in the urine of the cows. Although ^{54}Mn in the liver of cows indicated that some of it was absorbed, its poorer absorption compared to ^{137}Cs precluded appreciable secretion of fallout ^{54}Mn into milk. Thus ^{54}Mn in fallout does not contribute significantly to the γ-radiation hazard to the consumer. (BBB)

507 HIGH-ENERGY ELECTRON DOSE PERTURBATIONS IN REGIONS OF TISSUE HETEROGENEITY. PART II. PHYSICAL MODELS OF TISSUE HETEROGENEITIES. Almond, P. R.; Wright, A. E.; Boone, M. L. M. (Univ. of Texas, Houston). Radiology, 88: 1146-53(June 1967).

A number of conclusions can be made from these investigations. At distances behind bone, beyond the effect of the scattered contribution, the dose distribution can be calculated when the bone density is known. This is because the electron beam attenuation depends on the number of electrons/cubic centimeter in bone relative to unit density tissue. It is possible to define a coefficient of equivalent thickness (CET) that can be used to determine the dose distribution in lung tissue. The CET values can be calculated from

in vivo measurements and from phantom measurements. The CET value varies with energy, depth into the inhomogeneity, and density. By choosing the correct phantom material it should be possible to obtain good correlation of lung density. The determination of the dose within the chest wall is difficult. It is reduced by a few percentage points for the high energies owing to the decreased scatter contribution from the lung, but more work needs to be done at 6 MeV where the in vivo data show large reduction for thick chest walls; Air cavities affect the dose distribution. They can act to either increase, decrease, or have no effect upon the dose, depending upon the energy and field size of the electrons and the position of the cavity; The total dose is a combination of the dose from the primary beam plus that from scattered electrons. Any inhomogeneity in the beam that affects either one will alter the dose distribution. The magnitude of the perturbation is dependent upon energy, field size, density, and position, but in the simple cases reasonable corrections can be made. (auth)

508 RESULTS OF COMPARATIVE STUDIES IN A MAN-LIKE PHANTOM BETWEEN MEASURED AND COMPUTER-DETERMINED DOSE DISTRIBUTIONS WITH DIFFERENT RADIATION METHODS. Eichhorn, H.-J. (Robert-Roessle Hospital, Berlin). Radiology, 88: 1154-8(June 1967).

A comparison was made between dose distributions calculated by a digital computer and those measured by 120 thermoluminescent dosimeters (LiF) for telecobalt radiations to a man-like thorax phantom. Previous tests were made for accuracy, especially for the independence of wave length of the measuring method. Different types of moving-field therapy were employed. It is hoped to ensure that no essential errors are involved in the mathematical description of the correlations for inhomogeneities, nonperpendicular incidence, margin drop, scatter, or interposed wedge filters. The results of the two methods were in good agreement, and it is concluded that for practical radiation therapy the computer-calculated dose distributions may be used. It is pointed out that since the radiation effect is less selective for tumor tissue, it should, for best results, be supported by a selective dose distribution. While this requirement is fulfilled for surface and deep therapy, for corresponding clinical results depth therapy conditions may be achieved only by means of computers. Their use is therefore essential to improvement of the rate of lasting cures in deep therapy. This assumption was confirmed in the author's patients. Histologically a complete destruction of tumor was achieved in the majority of cases of carcinoma of bronchi and esophagi. (auth)

509 AUTOMATION OF RADIATION TREATMENT PLANNING. VI. A GENERAL FIELD EQUATION TO CALCULATE PERCENT DEPTH DOSE IN THE IRRADIATED VOLUME OF A ^{60}Co BEAM. Sterling, Theodor; Perry, Harold; Weinkam, Jay (Washington Univ., St. Louis. Sinai Hospital, Detroit). Brit. J. Radiol., 40: 463-8(June 1967).

This paper represents the next step forward in the development of a mathematical model that describes the total dose distribution in a field irradiated by a ^{60}Co source at any source-surface distance or angle of entry. To derive this extension the authors collected a large amount of data on dose values throughout a water phantom at different source-surface distances, for different field sizes and for beams entering the phantom at different angles. These data were collected automatically, using a mechanism which drove a Victoreen probe with a 3 mm ionization chamber through the total volume of a water tank. The basic form of the model which had been derived originally for 80 cm SSD was found to hold quite well in principle for any SSD. The general equation which was derived was found to use two sets of constants, one set for depth less than 2 in. and the other for depth of more than 2 in. This division was introduced to adjust for electron build-up over the initial depth. While the relations described in the mathematical model hold for both sections of the field, a single set of constants fitted to all the data did not yield an accuracy of dose determination comparable to dividing the field in two. The equations were next modified to give precise per cent of depth dose estimates for any off-axis points and make proper corrections for surface curvature. The final equations determine the per cent depth dose in the irradiated target volume of a ^{60}Co beam corrected for angle of entry, SSD and curvature of the irradiated medium with an accuracy that falls well within error of measurement. (auth)

510 INCREASED X-RAY DOSE ADJACENT TO PLANE BONE INTERFACES AS MEASURED IN POLYETHYLENE. Lentsch, Jack W.; Finston, Roland A. (Oregon State Univ., Corvallis). Phys. Med. Biol., 12: 543-50(Oct. 1967).

The increased x-ray dose to soft tissue adjacent to plane bone interfaces was measured as a function of x-ray quality and depth. The measurements were performed using a thin polyethylene-film dosimeter. Experimental data are presented for a variety of clinically useful x-ray qualities. Comparison of the results with calculated doses, assuming monoenergetic photons, shows discrepancies which are attributed to the x-ray spectra. It is shown that when the x-ray spectra are broad and of low quality (low kvp and low filtration) differences between the measured and calculated values are great. (auth) (UK)

511 THE MEASUREMENT OF ANTIMONY DEPOSITS IN THE LUNG. Day, M. J.; Hickling, Sheila M. (Newcastle General Hospital, Newcastle upon Tyne, Eng.). Phys. Med. Biol., 12: 455-67(Oct. 1967).

The principles of x-ray spectrophotometry were applied to the determination in vivo of antimony deposits in the lungs of industrial workers. The radiation source was ^{125}I that emits two effectively monochromatic components. The intensity of the beam transmitted through the patient was measured by a scintillation counter and its spectral composition determined by an absorption method. Preliminary results are given for a number of patients. (auth)

512 APPARENT ABSORPTION OF THE GAMMA RAYS OF RADIUM IN WATER. Smocovitis, D.; Young, M. E. J.; Batho, H. F. (British Columbia Cancer Inst., Vancouver). Brit. J. Radiol., 40: 771-7(Oct. 1967).

Values of the ratio of the exposure in a large water phantom to the exposure in air as a function of distance from a radium source have been remeasured since there are appreciable discrepancies between previously reported values. All measurements reported in this paper were made with small air-filled cavity ionization chambers. The chamber wall was at least 0.6 cm of Plexiglas in all cases to guarantee full electronic buildup and at least 0.3 cm additional Plexiglas was used either in the chamber wall or in "sleeves" surrounding the radium sources to absorb completely photoelectrons originating in the platinum surrounding the radium. The thicknesses required were determined in preliminary experiments which served, also, to determine the correction necessary for γ-ray attenuation in the Plexiglas. The results were independent of the size of ionization chamber used and the platinum filtration of the radium source. A graph is given comparing the results of different investigators. (auth)

513 THE CONTAMINATION OF OUR ENVIRONMENT DUE TO NUCLEAR TESTS. Blume, W. Radiobiol. Radiother., 8: 187-94(1967). (In German).

Environmental contamination resulting from nuclear tests was determined by the National Central Board of Radiation Protection. A review of the mechanisms of spreading and deposition of fission products in the atmosphere is presented. Radioactivity of the atmosphere near the ground following nuclear tests in 1962 was determined from measurements of total β activity of the air and fallout. Strontium-90 measurements of soils, plants, and foodstuffs are given. (H.L.W.)

514 MEASUREMENT OF BODY POTASSIUM. CALIBRATION AND INTERCOMPARISON OF TWO WHOLE-BODY RADIATION COUNTERS. Burkinshaw, L. (Univ. of Leeds, Eng.). Phys. Med. Biol., 12: 477-88(Oct. 1967).

The potassium contents of 13 men and 12 women were estimated by measuring the rate of emission from the body of γ-rays from the natural radioisotope ^{40}K. Measurements were made with two whole-body radiation counters. The counting rates from each subject were measured before and after an oral dose of ^{42}K. From these observations a calibration factor, F (gK/count per min), and an estimate of body potassium were calculated for each counter. The observed differences in the pairs of potassium estimates may occur because ^{42}K is not completely in equilibrium with the natural potassium in the body at the time of the second measurement, which was made 18 to 23 hours after administration of the dose. The calibration factor, F, varies with the weight W, and height H, of the subject, and the regression coefficients of F on W, on W and H, on (W/H) and on $(W/H)^{\frac{1}{2}}$ were calculated. The regression formulae can be used to predict the values of F for any subject of known height and weight. (auth)

515 MEASURING THE DOSE RATE IN THE STRAY RADIATION FIELD OF AN X-RAY MACHINE FOR CALIBRATION PURPOSES. Piesch, E. (Kernforschungszentrum, Karlsruhe, Ger.). Atompraxis, 13: 347-52(Aug. 1967). (In German).

The stray radiation field of a shielded x-ray machine (300 kV) was measured with a plastic proportional counter for different radiation qualities in the energy range of 38 to 240 KeV. The influences of added tube filters, different radiation energies, and straying objects on the dose rate of the stray radiation field were investigated. Furthermore the particular radiation components resulting from tube filters, radiation aperture, useful beam, and tube housing were determined. (auth)

516 RECOIL PROTON DOSE AT A BONE-TISSUE INTERFACE IRRADIATED BY FAST NEUTRONS. **Lawson, R. C. (United Kingdom Atomic Energy Authority, Chapelcross, Scotland). Phys. Med. Biol., 12: 551-4(Oct. 1967).**

The recoil proton dose in a body irradiated by fast neutrons is normally determined using a polythene phantom filled with a liquid simulating soft tissue. The perturbation to the dose by the presence of bone is considered for the particular case of two parallel slabs of bone surrounded by tissue. Typical dose curves in bone and tissue of various thicknesses are illustrated for 14 MeV neutrons and can readily be applied to neutrons of lower energy by an appropriate scaling factor. The effect of the perturbation on the recoil proton LET spectra is discussed. (auth) (UK)

517 QUANTITATIVE COUNTING IN THE PRESENCE OF COINCIDENCE-SUMMING SCINTILLATIONS. **Ross, D. A.; Rohrer, R. H.; Harris, C. C. (Oak Ridge National Lab., Tenn.). Contract W-7405-eng-26. J. Nucl. Med., 8: 502-14(July 1967). (ORNL-P-2702).**

Certain radionuclides emit pairs of photons so nearly simultaneously that if both members of the pair reach a detecting crystal the effects of their scintillations are additive. This makes the pulse-height spectrum depend on the detector geometry and the only safe way to avoid trouble, in quantitative counting, is to count the unknown sample and its standard of comparison in the same geometry. When accurate duplication of the geometry is not possible for example, if the unknown is inside a patient, the errors can be reduced by proper selection of the energy band. When high-geometry assay procedures are used, the coincidence-summing probabilities must be carefully taken into account. (auth)

Medicine

Refer also to abstracts 228, 432, 445, 554, 571, and 1914.

518 (UCLA-12-655) RECENT ADVANCES IN KIDNEY SCANNING. **Taplin, George V.; Swanson, Leonard A.; Hayes, Michael (California Univ., Los Angeles. Lab. of Nuclear Medicine and Radiation Biology). Sept. 5, 1967. Contract AT-04-1-GEN-12. 28p. (CONF-670940-1). Dep. CFSTI.**

From Symposium on the Clinical Applications of Nuclear Medicine, Boston, Mass.

With the recent availability of the Ter Pogossian x-ray image amplifier camera and ^{99m}Tc labeled kidney specific agents, renal cine-scintography became feasible for basic studies in animals and for clinical investigation in the near future. Presently, sequential kidney imaging at one to two minute intervals, by scintillation cameras or the ten probe rapid scanner shows great promise with ^{131}I OIH or ^{99m}Tc-Fe-chelates by single intravenous injection. The high photon flux attainable with these agents, greatly increases the functional significance and resolution of the scan images. Simultaneously, radiation exposures are reduced far below those with conventional mercury scans. Dynamic kidney scanning, although in its early stages of development, already shows great promise as a useful procedure in the assessment of differential kidney function, particularly in suspected renal vascular hypertension and in the pre and post operative management of upper urinary tract obstruction. Further advances are predicted in the near future because of the growing effort now being expended in the development of new or improved radiopharmaceutical agents and in rapid organ imaging equipment. (auth)

519 PROTECTIVE EFFECT OF 6-AZATHYMINE AND 6-AZAURACIL AGAINST THE LETHAL EFFECT OF ULTRAVIOLET IRRADIATION. II. ISOLATION OF THYMINE PHOTOPRODUCTS FROM THE NUCLEIC ACIDS OF STREPTOCOCCUS FAECALIS. **Gunther, Helge L.; Prusoff, William H. (Yale Univ., New Haven). Biochim. Biophys. Acta, 142: 304-13(1967).**

Streptococcus faecalis (ATCC 8043) grown in the presence of either [^{3}H]thymidine or [2-^{14}C]thymine (8 μM) and a partially inhibitory concentration of either 6-azathymine (60 μM) or 6-azauracil (660 μM) showed, after ultraviolet irradiation (2537 Å), a 10-20-fold higher number of survivors than cells grown in a limiting concentration of either thymine or thymidine (4 μM). No significant difference was found between the various treatments in the amount of thymine dimer formed in the acid-insoluble fraction on irradiation. In addition to thymine dimer, a second photoproduct, occurring in smaller amounts was detected. Growth in the presence of the analogs did not select a population of higher resistance to the lethal effects of ultraviolet irradiation. The presence of a mixed dimer of thymine and 6-azathymine was not detected. (auth)

520 RADIATION-INDUCED INACTIVATION OF TRYPSIN-INHIBITOR SYSTEMS. **Kabi, A.; Singh, B. B.; Charlesby, A. (Royal Military Coll. of Science, Shrivenham, Eng.). Int. J. Radiat. Biol., 12: 183-5(1967).**

The radioprotective effects of egg ovomucoid and soybean trypsin inhibitor (SBTI) on the radioinduced inactivation of trypsin was investigated. Samples (5 ml) of air-equilibrated solutions of the inhibitors (0.016%) and enzyme-inhibitor complexes (4:1) in phosphate buffer at pH 6.6 were irradiated at ambient temperature with ^{60}Co γ-rays at a dose rate of 293 krads/hr and the esterase activity of the enzyme was measured. At these concentrations, nonirradiated solutions of the inhibitors reduced the activity of trypsin by 25%. The D_{37} values (radiation dose required to reduce the enzymatic activity to 37% of the initial value) for trypsin-ovomucoid (42.5 krads) and trypsin-SBTI (52 krads) mixtures were higher than that of irradiated trypsin alone (35 krads); these results indicated that the inhibitors at low concentrations appeared to protect the enzyme. A radioprotective effect was also exerted by γ-inactivated ovomucoid and SBTI. In freeze-dried trypsin-inhibitor systems no such protective effects were observed. It was concluded that the radioprotective effect offered by the inhibitors was not due to the breakage of linkages between the inhibitor and trypsin but rather to the simple scavenging of radical species produced during the initial radiolysis of water that otherwise inactivated trypsin. (B.H.S.)

521 POST-RADIATION RECOVERY IN SPERMATIDS SAMPLED FROM 24 HR OLD PUPAE OF DROSOPHILA MELANOGASTER. **Watson, W. A. F.; Sankaranarayanan, K. (Univ., Leiden). Genetica, 38: 62-3(1967).**

Male pupae with a ring-X chromosome of the genetic constitution $X^{Cy}y$ B/sc^{8}Y were subjected to 6 hr pretreatment with N_2, irradiated under anoxia with a high dose-rate of 46 R/sec at three different exposure levels (1250 R, 2500 R and 3750 R) and then posttreated for two hours with either N_2 or O_2. Following eclosion, the males were mated individually with six females for a 24 hour period and the progeny were utilized for sex-linked lethal and translocation tests. The results indicated a consistent and highly significant decrease in mutation and translocation frequencies following O_2 posttreatment and that the absolute reduction of the lethal frequencies was approximately the same at the three exposure levels. This was conceivably due to the fact that the repair system could cope with only a limited amount of damage and became saturated at high doses so that the repair was most effective when the dose was low. The results confirmed and provided additional evidence for the postulated oxygen-dependent repair system operating in spermatids. The effects of four dose rates (16.6 R/sec, 8.3 R/sec, 4.2 R/sec and 2.1 R/sec) at two exposure levels (2500 R and 1250 R) were investigated. The results indicated that the frequencies of sex-linked lethals at both the levels of radiation exposure were far from being significantly different between the N_2 and O_2 post-treated groups. A comparison of these results with those of high dose-rate studies revealed that after irradiation at low dose rates, the mutation frequencies following both N_2 and O_2 post-treatments were strikingly similar to those obtained at high dose-rate exposures with N_2 post-treatment indicating that at lower dose rates, O_2 post-treatment was no longer effective in bringing about repair. A possible explanation of these observations was that the repair process in spermatids proceeded in such a short time that after prolonged exposures to irradiation, no repair was possible. (B.H.S.)

522 PHYSICAL-TECHNICAL BASIS OF RADIOTHERAPY WITH ^{137}Cs. **Harms, Ingrid; Kuttig, Helmut (Zentralroentgeninstitut der Staedtischen Krankenanstalten, Karlsruhe, Ger.). Roentgen. Bl., 18: 472-8(Oct. 1965). (In German).**

The γ irradiation from ^{137}Cs is superior to 200 KV x radiation for therapy, and almost equally valuable as a hard radiation source as ^{60}Co γ irradiation. It has a high skin tolerance, favorable mass absorption coefficient, small space dose, and a high relative depth dose. In all, the γ irradiation from ^{137}Cs fulfills all the preconditions of an irradiation source suitable for radiotherapy. Its use even in small radiological installations is justified because of its excellent characteristics. Compared to radiotherapy with ^{60}Co, treatment with ^{137}Cs for surface and half depth therapy results in protection of the deep lying healthy organs and the radiation exit field. In depth therapy ^{137}Cs has a somewhat smaller relative depth dose than ^{60}Co, but the difference is small. (BBB)

523 DIAGNOSIS AND THERAPY OF ACUTE RADIATION DAMAGES. **Morczek, A.; Sitzlack, G.; Geipel, R.; Raube, D.; Schuettmann, W.; Thiele, H.; Zeuner, A. (Strahleninstitut der Medizinischen Akademie, Magdeburg, Ger.). Deut. Stomatol., 16: 585-98(Aug. 1966). (In German).**

General guidelines for the diagnosis and treatment of acute irradiation injuries, alone or in combination with mechanical injuries (open wounds, fractures, internal injuries), burns, infections, and poisons are described. Various characteristics

of irradiation injury such as external or internal irradiation, types and extent of injuries are itemized. Irradiation injuries are classified according to severity as a basis for treatment. Three groups are recognized: injuries from doses of 750 rem or more, where survival is unlikely; injuries from 300 to 750 rem, where survival is possible; and injuries from 100 to 300 rem, where survival is probable. Diagnostic approaches are itemized, including tests of hematopoietic function, skin, gastrointestinal tract, central nervous system, and water and electrolyte balances. General and specific treatment procedures are outlined. The procedures and methods indicated in this report are intended as a guide for physicians who may be required to diagnose and treat patients exposed to radiation or with related mechanical injuries. (BBB)

524 THE MYSTERIES OF RADIATION. 2. EFFECTS AND TREATMENT OF OVER-RADIATION. O'Connor, K. J. R. (HMS Collingwood, Fareham, Eng.). Nursing Times, 62: 1452-3 (Nov. 4, 1966).

Treatment of persons who were accidentally exposed to excessive doses of ionizing radiation is outlined; nursing care that is required is emphasized. Symptoms and generalized effects of irradiation are reviewed. Treatment of severe radiation sickness in man is considered with respect to the following: careful nursing in an aseptic ward; replacement of blood; use of antibiotics; addition of vitamins to the diet; electrolyte control; and maintenance of morale. (TSS)

525 REACTIONS OF MERCAPTOAMINES. III. SYNTHESIS OF N-MONOSUBSTITUTED 2-MERCAPTOETHYLAMINES. Ferris, Arthur F.; Salerni, O. LeRoy; Schutz, Beverly A. (Midwest Research Inst., Kansas City, Mo.). J. Med. Chem., 9: 391-4 (May 1966).

Because of the potential use of 2-mercaptoethylamines as antiradiation drugs, additional synthetic routes to compounds of this class were devised. Studies of the reactions of mercaptoamines have shown that many compounds capable of reacting with the amine function also react with the mercaptan function. A method was devised for protecting the mercaptan function in 2-mercaptoethylamine, allowing the amine function to react, and then regenerating the free mercaptan. N-Monosubstituted 2-mercaptoethylamines were thereby obtained. The synthesis involved conversion of 2-mercaptoethylamine by reaction with nitriles to 2-substituted 2-thiazolines, quaternization of the thiazolines by tosylate esters to thiazolinium salts, alkaline hydrolysis of the salts to an N-(2-mercaptoethyl) acetamide derivative, and hydrolysis of the amides in concentrated HCl and glacial acetic acid to N-monosubstituted 2-mercaptoethylamines. Nine N-monosubstituted mercaptoethylamines ($HSCH_2CH_2NHR$) were examined for protective activity against radiation lethality in mice. The compound where R was phenethyl was found to have good protective effectiveness. The compound where R was 2-(2-thienyl)-ethyl possessed fair activity. Slight activity was assigned to those compounds where R was p-t-butyl-phenoxyethyl, p-chlorophenoxyethyl, and 3-phenoxypropyl. Other N-monosubstituted mercaptoethylamines tested were inactive. Some thiazolinium salts and acetamide derivatives were also examined for protective activity against lethal doses of radiation. All compounds were inactive. The thiazolinium salts were tested on the premise that they may undergo in vivo hydrolysis to the corresponding N-monosubstituted mercaptoethylamine. The compounds were administered intraperitoneally to mice tested for 30-day survival against a lethal radiation dose of 1000 R. (BBB)

526 RADIOSTRONTIUM ABSORPTION IN MAN. Spencer, Herta; Lewin, Isaac; Samachson, Joseph (Veterans Administration Hospital, Hines, Ill.). Lancet, 2: 156 (July 15, 1967).

Use of aluminum-phosphate gel in preventing absorption of ^{85}Sr in man was studied. Seven patients received a low-Ca diet containing an average of 220 mg Ca and 800 mg P per day. A single tracer dose of ^{85}Sr-labeled strontium chloride was given orally, then plasma levels, and urinary and fecal excretions of the radioisotope were determined. After four weeks, the experimental studies were done in the same patients under the same constant dietary conditions. Strontium-85 was given orally immediately after 100 to 300 ml of aluminum phosphate gel (a water suspension containing 3.8 to 4.5% of aluminum phosphate) was administered. The ^{85}Sr plasma levels were much lower in each case in which the gel was used than in the control studies. Absorption of ^{85}Sr from the intestine was thus greatly inhibited, as also shown by the increased fecal excretions of ^{85}Sr. In the control studies the absorption of ^{85}Sr averaged 26.8% of the administered dose, and in the aluminum phosphate gel studies it averaged 2.7%, corresponding to an average decrease in ^{85}Sr absorption of 89.6%. The lowest amount of aluminum phosphate gel used, 100 ml, was as effective as 300 ml. (BBB)

527 NEW QUANTITATIVE METHOD FOR DETERMINATION OF MITRAL REGURGITATION BY CONTINUOUS INFUSION OF AN INERT GAS (^{85}Kr) IN AQUEOUS SOLUTION. Lyngborg, Kjeld; Lindeneg, Cle; Mellemgaard, Kresten (Rigshospitalet, Copenhagen). Verh. Deut. Ges. Kreislaufforsch., 31: 285-8 (1965). (In German).

In the new technique which is described, a solution of ^{85}Kr in saline is infused at a constant rate into the left ventricle. Blood is sampled from the left atrium, a peripheral artery, and the pulmonary artery during and following the infusion. Mitral regurgitation is calculated from the ^{85}Kr concentrations in the left atrium and peripheral artery after correction for the recirculation through the lungs. When the infusion is discontinued, ^{85}Kr concentrations in the left atrium and systemic artery rapidly approach identical low values. The ratio between left atrial and pulmonary artery concentrations now obtained is used as an estimate of the relative recirculation through the lungs. Cardiac output is calculated from the infusion rate and the arterial concentration. The radiation dose delivered during this procedure is estimated to be about 5 mrad to the whole-body and 20 mrad to the epithelium of the respiratory tract, or about the same exposure received during 1 chest x ray. (BBB)

528 EFFECTS OF EXPOSURE, FREEZING, AND RADIATION ON EXPLANTED GASTRIC MUCOSA. Harata, Nobumasa (Tohoku Univ., Sendai); Vokins, Colin; Ferguson, Donald J. Amer. J. Dig. Dis., 12: 674-84 (July 1967).

It is practically impossible in a living animal to irradiate or to freeze the gastric mucosa selectively and uniformly in situ. An explant of gastric mucosa to the outer surface of the abdominal wall was used to provide a means for more quantitatively applying these agents, and to facilitate follow-up of the effects. Methods of preserving structure and function of canine gastric explants were investigated, and irradiation and freezing applied to different explants in the same animal at various stages of preservation of the mucosa. Results were studied with respect to mucosal histology, secretion of acid, and capacity of heal factitious ulcers. Radiation was given in a single dose of 800 rad. The entire explant was x irradiated while the rest of the animal was shielded with lead. Freezing was applied to a different explant immediately before or after the irradiation. The canine fundic gastric mucosa was explanted onto the abdominal wall in three vascularized pieces, each about 3 cm in dia. Some explants were covered with skin or plastic, and others remained exposed. Explants covered with skin retained nearly normal histologic features and secreted acid. Those covered with plastic were less well preserved, and those without cover lost all parietal and chief cells. Both irradiation and freezing caused some degree of necrosis. The radioinduced lesions were slower and milder at the onset; a slightly more damaging effect was noted later. The doses of freezing and radiation used were, therefore, near equivalent in over-all effect. Solid freezing of gastric mucosa was always followed by sloughing and ulceration. The effects of irradiation were much more gradual, and acid secretion was only moderately reduced. Histologic changes were correspondingly mild. Gastric mucosa β irradiated with an intracavitory balloon containing ^{32}P revealed similar findings in the folds where radiation was less intense, while the more heavily affected areas close to the balloon (which received over 4000 rad) underwent almost complete loss of normal structure that persisted for several months. A radiation dose sufficient to cause necrosis comparable to that produced by freezing interfered with subsequent regeneration of the mucosa more than the freezing did. The effect after two months was appreciably less than that of freezing with respect to histology and secretory capacity, whereas ability to heal ulcers in skin-covered explants was the same. Irradiation slowed healing more than freezing did in long-exposed explants. (BBB)

529 MECHANISM OF ACTION OF THE SKIN-PHOTOSENSITIZING FUROCOUMARINS. Musajo, L.; Rodighiero, G. (Univ. of Padua). Acta Dermato-Venerol., 47: 298-303 (1967).

The biological mechanisms through which some furocoumarins exert a photosensitizing effect on human and guinea pig skin for uv irradiation were investigated. Unlike many other photodynamic substances which act by a photooxydative mechanism, the furocoumarins are completely lacking in photooxidative properties and, under uv irradiation (365 mμ) they undergo photocycloaddition with the pyrimidine bases (thymine and cytosine) contained in DNA. A stable fixation of the furocoumarins to the macromolecule takes place, without breakages of the internucleotide bonds. After considering the different mechanisms of action between the furocoumarins and many other photodynamic substances, it was suggested that the term photosensitizing be reserved for the furocoumarins (activity independent of oxygen) with retention of the, until now commonly employed, photodynamic designation for other substances with oxygen-dependent activity. (BBB)

530 APPLICATION OF LOW-ENERGY GAMMA EMITTERS IN SCINTILLATION SCANNING. Husak, V.; Kuba, J. (Palacky Univ., Olomouc, Czech.). Jad. Energ., 13: 381-7(Oct. 1967). (In Czech).

Methods calculating the mean beta-ray energy, total number of K and gamma photons per disintegration, and the specific gamma-ray constant for some low-energy gamma sources (^{125}I, ^{197}Hg, ^{99m}Tc, ^{199}Au, ^{57}Co, ^{131}Cs) are presented. Low absorbed radiation dose, possibility of employment of thin scintilation crystals with low background, and possibility of construction of high efficiency collimators represent chief advantages of these radioisotopes for medical scanning in contradistinction to clasical emitters (^{131}I, ^{198}Au etc). Low energy emitters have also some disadvantages of less importance. Characteristics, measurements and clinical use of ^{197}Hg and ^{99m}Tc are described. (auth)

531 XEROMAMMOGRAPHY AND FILM MAMMOGRAPHY: COMPLETION OF A COMPARATIVE STUDY. O'Mara, Robert E.; Ruzicka, Francis F. Jr.; Osborne, Alan; Connell, James Jr. (St. Vincent's Hospital, New York. Medical Center of New York, N. Y. New York University Coll., N. Y.). Radiology, 88: 1121-6(June 1967).

A different modality for examining breast lesions, namely xeroradiography, was introduced. The diagnostic accuracy of this procedure is similar to that of conventional film mammography. It may be noted that our experience in interpreting xeroradiographs is in its infancy, and the equipment and technics are in an early stage of development. The advantages of lower patient x-ray exposure, the ability to see all structures on a single image, and the sharp delineation of even small differences in glandular structure are considerable. Most of the disadvantages, such as the tendency of the selenium-coated plates to produce artefacts and the wood frame around the plate that reduces the amount of breast that can be included in the craniocaudal view, are technical areas in which one can look for improvement as the equipment and technic become more refined. (auth)

532 HEPATIC SCINTISCANNING: A PROMISING DIAGNOSTIC PROCEDURE IN LIVER TRAUMA AND SUBDIAPHRAGMATIC ABSCESS. Burdine, John A. Jr.; Hill, Charles A. (Baylor Univ., Houston, Tex. Ben Taub General Hospital, Houston, Tex.). Radiology, 88: 1131-45(June 1967).

The use of hepatic scintiscanning in diagnosing subdiaphragmatic abscess and liver trauma is presented. Appropriate scan abnormalities prove to be diagnostic in most cases of subdiaphragmatic abscess, though two cases of hepatoma were mistaken for the nonneoplastic condition. All the major liver lesions such as tears and penetrations which were visualized at surgery were suspected previously on the basis of scan findings. The abnormal space above the liver in subdiaphragmatic abscess can be demonstrated only when the diaphragm can be seen on the chest roentgenogram. Consequently, we have relied on changes in the diaphragmatic contour of the scan image for diagnosis. It is our opinion that the combined liver-lung scan does not offer a dependable means of localizing the diaphragm. (auth)

533 RADIOPROTECTIVE AGENTS: RESULTS WITH S-(3-AMINO-2-HYDROXYPROPYL) PHOSPHOROTHIOATE, AMIDOPHOSPHOROTHIOATE, AND SOME RELATED COMPOUNDS. Akerfeldt, S.; Ronnback, C.; Nelson, A. (Research Inst. of National Defense, Sundbyberg, Sweden). Radiat. Res., 31: 850-5 (Aug. 1967).

Two S-phosphorylated thiols, dilithium S-(3-amino-2-hydroxypropyl) phosphorothioate and S-(2-aminopropyl) phosphorothioate, were shown to be good radioprotectors when given to mice before irradiation with x-rays. The observed dose-reduction factors were 2.16 and 1.86, respectively. The reference substance, cysteamine, gave a dose reduction of 1.84. There was a significant difference in radioprotective effect of S-(3-amino-2-hydroxypropyl) phosphorothioate if given in solution at pH 10 or at pH 7. A new class of radioprotectors, diammonium amidophosphorothioate and diammonium thiodiamidodiphosphate, gave dose-reductions factors of 2.30 and 2.16, respectively, at molar doses lower than that of cysteamine by a factor of 10 to 20. (auth)

534 BONE-MARROW GRAFTING ATTEMPTS IN MARMOSETS AFTER WHOLE-BODY IRRADIATION. Gengozian, N.; Batson, J. S.; Nelson, B. M. (Oak Ridge Inst. of Nuclear Studies, Tenn.). Contract AF 41(609)-2186. Int. J. Radiat. Biol., 11: 553-61(1966).

Marmosets were exposed to lethal whole-body gamma radiation doses (^{137}Cs) of 400 R, 600 R, and 800 R. Intravenous injections of homologous marrow after irradiation did not prolong life in the 400 R group, and significant extension of survival with marrow injections was obtained only after 600 R and 800 R, the maximum 33 days after 600 R. In suitable male-female donor-host combinations, a donor graft was identified in four of seven animals receiving 800 R and homologous marrow, but the recovery from anemia, leukopenia, and thrombocytopenia was poor in all groups. The inefficacy of homologous-marrow in promoting extended survival and hematological recovery is considered to be due primarily to immunological reactions between host and donor. However, an intrinsic biological factor, the natural blood chimaerism that is presumed to exist in most marmosets, is an additional variable complicating definitive evaluation of any transplantation attempts. (auth)

535 RECENT TRENDS IN CURIE THERAPY. ^{192}Ir. Sinistrero, G. (Institut Gustave Roussy, Villejuif, France. Univ., Turin). Minerva Radiol., Fisioterap. Radiobiol., 12: 133-40(Apr. 1967). (In Italian).

The advantages and drawbacks of using radium and the various isotopes in interstitial therapy are dealt with briefly. Iridium-192, in particular, is mentioned in a description that stresses and lists the methods of use. In addition, an original dosimetric system based on the use of tomograms perpendicular to the radioactive preparations, is indicated. Lastly, the main clinical aspects are touched upon. Iridium-192 is marked out as the radioisotope which, at least at present, best lends itself to everyday use in interstitial therapy. (auth)

536 THE ROLE OF TIME-SPACED UROGRAPHY IN THE DIAGNOSIS OF RENO-VASCULAR HYPERTENSION. Venturoli, L.; Lenzi, M. (Univ., Pisa, Italy). Minerva Radiol., Fisioterap. Radiobiol., 12: 108-15(Apr. 1967). (In Italian).

A brief account is given of the physiopathological mechanism, technique and radiological pictures given by the use of close time-spaced urography, and reference is made to pictures typical of renovascular hypertension. On the basis of the most recent literature and personal experience a critical examination of the method is offered and its scope and limitations are pointed out. The conclusion is drawn that it can be a satisfactory investigatory test for use on hypertensive patients but that these must be afterwards subjected to further radiological, biochemical and histological examinations. (auth)

537 EXPERIMENTAL STUDY OF THE BIOLOGICAL FATE OF ROSE BENGAL-^{131}I. PROBLEMS RELATED TO THE EVALUATION OF HEPATIC FUNCTION. Tarolo, G. L.; Mombelli, L.; Colombo, L.; Conte, L. (Univ., Milan). Med. Nucl. Radiol. Lat., 9: 333-50(1966). (In Italian).

In order to use rose bengal-^{131}I for quantitative evaluation of hepatic function, an experimental study was made of the principal kinetic aspects of this tracer in the human body. Factors studied included the curve of plasmatic concentration of rose bengal-^{131}I, the distribution space of the tracer, the possibility of an enterohepatic recycle, and the role of free ^{131}I in the solution injected and that which might be liberated in the organism through the detachment of the molecule of rose bengal. On the basis of the resulting experimental data it is concluded that quantitative kinetic analysis of this tracer cannot refer to a simple catenary model, but requires a more complex model which would explain the plasmatic curve, which is not referable to a single exponential function. The possibility is also discussed of utilizing the curves registered in vivo on the temple and on the hepatic area expressing plasmatic and hepatic activity. It was shown that such a possibility exists when certain technical devices are adopted for the registration and normalization of the 2 curves so as to avoid significant error in quantitative analysis. (auth)

538 SCINTIGRAPHIC STUDY OF CEREBRAL HEMISPHERES USING MAA-^{131}I INJECTED IN THE CAROTID. Blandino, G.; Conforti, P.; Bonanno, N.; Armenise, R. (Univ., Messina, Italy). Med. Nucl. Radiol. Lat., 9: 319-32(1966). (In Italian).

Results are described of initial experiences of cerebral scintigraphy, using albumen macro-aggregates labeled with ^{131}I introduced into the carotid. With this method, extremely useful information can be obtained on the physiopathology of the arteriolar and capillary bed and on those pathological processes which could affect it directly or indirectly. Three clinical cases are described, which are considered representative of fundamental groups of pathological alteration, which could be effectively examined with this method: intracerebral lesions showing a confined increase of vascularization appear as focus-points of hyperfunction, lightly perfused and therefore hyperfunctioning lesions and primitive alterations of the large cerebral vessels, with modified blood flow in the area of perfusion. The experiment was repeated on a limited group of patients, but none revealed signs of cerebral damage attributable to this method. In view of results and of evaluation of the method, the possibilities of development of cerebral scintigraphy are stressed, and its future in physiopathology of cerebral circulation studies and in the diagnosis of encephalic lesions is discussed. (auth)

539 MEASUREMENT OF THE REGIONAL DISTRIBUTION OF ARTERIAL BLOOD FLOW IN THE HUMAN FOREARM AND HAND. **Bardfeld, P. A.; Lopez-Majano, V.; Wagner, H. N. Jr. (Johns Hopkins Medical Institutions, Baltimore). J. Nucl. Med., 8: 542-50(July 1967).**

The regional distribution of blood flow through vessels less than about 15 micra in diameter in the forearm, hand, and finger was measured by radioisotope scanning after intra-arterial injection of 300 μC of ^{131}I-labeled-macroaggregated albumin. The blood flow was distributed primarily to the muscle masses. In 11 selected control subjects, plus three patients with clubbing of the fingers and three patients with Raynaud's phenomenon, the regional distribution of blood flow in the forearm, hands, and fingers was essentially the same. (auth)

540 COMPARISON OF THE SCINTILLATION CAMERA WITH A CONVENTIONAL RECTILINEAR SCANNER USING ^{99m}Tc PERTECHNETATE IN A TUMOR BRAIN PHANTOM. **Telander, Gerald T.; Loken, Merle K. (Univ. of Minnesota, Minneapolis. Veterans Administration Hospital, Minneapolis). J. Nucl. Med., 8: 481-550(July 1967).**

Critical physical factors which limit the ability of a scintiphotographic system to demonstrate intracerebral space-occupying lesions are volume of the lesion; location within the brain; the tumor-brain radioactive concentration ratio; absolute concentration of radioactivity in the tumor; and type and amount of radionuclide tracer agent injected. Our study emphasizes the importance of the first three factors in evaluating in vitro methods of brain tumor detection. A water ^{99m}Tc brain tumor phantom was used to compare scintiphotograms obtained with the scintillation camera and the conventional rectilinear scanner. Pseudotumor volumes and tumor-brain radioactive concentration ratios were found to relate inversely in a straight line manner when plotted on log-log graph paper if one uses limits of resolution as defined in this study. It was found that pseudotumors near the midline of the phantom brain were more difficult to visualize than those in a more lateral position. Using optimal instrument settings, pseudotumor volumes which were barely detectable were 0.6 cc and 50 cc and required tumor-brain concentration ratios of 20:1 and 1.3:1 respectively to be visualized in a lateral position, provided the technical factors had been adjusted to optimal settings. The results compare favorably with other workers investigating the resolvability of pseudotumors with respect to their size and their radioactivity as compared to the surrounding media. Both the conventional rectilinear scanner and the scintillation camera showed similar resolving characteristics when the same pseudotumor-brain phantom systems were used. If optimal camera settings are used, the examination times for both the rectilinear scanner and the camera are very nearly equal. One practical advantage of the scintillation camera over the conventional scanner is that the camera detector may be moved with ease to a variety of different positions. Caution must be exercised when attempting to transfer data from phantom studies such as this to actual clinical studies of the human brain because of obvious differences between the complex anatomical structures of the brain and the relatively simple materials used in the tumor-brain phantom. (auth)

541 ^{99}Tc THYROID SCANS OBTAINED INCIDENTAL TO BRAIN SCANS. **Quinn III, James L.; Brand, William N. (Northwestern Univ., Chicago). J. Nucl. Med., 8: 481-6(July 1967).**

Thyroid scans were obtained incidental to brain scanning with ^{99m}Tc-labeled pertechnetate in 767 patients. Of these, 604 (78.7%) had thyroid scans that were considered interpretable. Of these 143 (18.6%) were adjudged normal, 223 (29.0) nodular, and 238 (31.0) inhomogeneous. This latter category is probably due to insufficient data recording (<1800 cp cm^2) and incomplete resolution of smaller nodules (<12 mm). (auth)

542 EFFECT OF POST-IRRADIATION TREATMENTS ON THE DEVELOPMENT OF SKIN DAMAGE IN THE MOUSE TAIL. **Shewell, Jennifer; Wright, E. A. (St. Mary's Hospital, London). Int. J. Radiat. Biol., 12: 127-34(1967).**

The effect of various local treatments on the rate of onset of damage after a standard dose of 8-MeV electrons to the mouse tail was investigated. The tail was compressed and a 2.5 cm portion exposed to 9000 rads, a dose that produced a clearly-marked scale of damage, ending in the loss of the tail distal to the irradiated section. The effect of the postirradiation treatments used on the mitotic activity of nonirradiated skin was measured by their action on the basal epidermal cells of the ear. Substances that stimulated mitosis, such as formalin and Teepol, hastened the rate of appearance of radiation damage. Keeping mice at 4°C which lowered the skin temperature of their extremities, delayed the rate of onset of damage, but the pattern of damage, once started, was the same whatever the treatment. It was concluded that alterations in mitotic rate induced topically after local irradiation altered the rate of onset of radiation damage. (auth)

543 RADIOACTIVE CHROMIC PHOSPHATES: COMPARATIVE STUDY OF THE IN VIVO DISTRIBUTION AND FEASIBILITY OF PREPARATION. **Anghileri, Leopoldo J. (Institut fuer Nuklear Medizine, Heidelberg). J. Nucl. Med., 8: 617-21(Aug. 1967).**

Chromic radiophosphate was used extensively for irradiation of tumors, palliation of malignant effusions, and for prophylaxis following surgical tumor removal. Several methods of preparation are currently in use and the final product can have different chemical, as well as physico-chemical properties, that could produce a different biological behavior. The present work is a comparative study of the chromic phosphate in vivo distribution, of the possibility of its hydrolysis in the tissues and of the feasibility and radiochemical yield of the method of preparation. The radiopreparations that were assayed are listed. (auth)

544 A BUFFER STORAGE INTERFACE FOR USE IN RECORDING INDIVIDUAL SCINTILLATION PULSES ON MAGNETIC TAPE. **Smith, R. O.; Love, W. D. (Univ. of Mississippi, Jackson). J. Nucl. Med., 8: 607-10(Aug. 1967).**

Several approaches to digital recording of medical isotope scanning data are reviewed. In the present case, pulses detected during scanning were recorded on magnetic tape in a form suitable for automatic entry into a digital computer. To record the 0.7 μS output pulses from the pulse height analyzer (Hamner N685) would require a tape recorder speed of approximately 480 in./sec when used in the pulse mode. The FM mode would require higher speeds. At the slower tape speeds that were available, shaping of the pulses was required to increase their duration. Loss of the randomly spaced pulses occurred when a second was detected while a previous one was being recorded. A buffer storage interface (derandomizer) was designed that permitted recording of up to 25,000 analyzer output pulses per second on magnetic tape at 60 in./sec with approximately one percent loss caused by coincidence of counts. Maximum time displacement of any pulse was 125 μS at 60 in./sec. The maximum counting rates for 1% losses at six recording speeds are presented in tabular form. (auth)

545 EFFECT OF X-RAY IRRADIATION ON THE PROPERDIN TITER OF HUMAN SERA. **Dalos, B.; Bihari, C.; Godan, F. Radiobiol. Radiother., 8: 263-9(1967).**

The influence of total and sub-total x ray treatment on the serum properdin titer was investigated. It was concluded that by this treatment no harm was done to the patients, showing very slight and inconsistent changes and no changes at all, respectively, in the properdin titer of their sera. (auth)

546 COAXIAL INSERTER FOR RADIUM NEEDLES. **Pantoja, Enrique; Holodny, Edward I. (State Univ. of New York, N. Y.). Radiology, 89: 742-3(Oct. 1967).**

The draftsman's standard lead-holder may be adapted as a radium inserter, the radium needle taking the place of the lead of the pencil. When used as described here, it shortened insertion time and thereby reduced exposure to the operating team. It also improved the technical quality of the implants and resulted in a more homogeneous dose distribution. (auth)

547 NORMAL TISSUE DAMAGE AND TUMOR CURE PROBABILITY FOR IRRADIATION GIVEN UNDER DIFFERENT CONDITIONS OF TISSUE OXYGENATION IN HYBRID MICE. **Suit, Herman D.; Howard, Thomas C. (Anderson Hospital and Tumor Inst., Houston, Texas). Radiology, 89: 720-6(Oct. 1967).**

Reaction of normal skin of the thighs and legs of mice to single-dose or fractionated irradiation was studied for treatments administered under normal, hypoxic, or high pressure oxygen conditions in mice. The results were described in terms of the dose producing a 4 + desquamation response, 4 + epilation response, or a specified contraction of skin in half of the irradiated sites. These were compared with the TCP (tumor cure probability) for a mouse mammary carcinoma. These analyses showed that for a specified damage to normal skin the TCP was highest when fractionated radiation doses were administered under normal or air breathing conditions. The increase in total dose to produce a reaction in normal skin when radiation was administered in 10 doses instead of a single dose was evaluated in terms of repair of sublethal damage and proliferation of surviving cells between dose fractions. (auth)

548 EFFECT OF ANOXIA ON RADIATION INJURY AND RECOVERY. **Phillips, Theodore L.; Hanks, Gerald E. (Naval Radiological Defense Lab., San Francisco). 9p. (CONF-650560-21). DTIE.**

From 13th Annual Meeting of the Radiation Research Society, Philadelphia.

A conditioning dose of x radiation of two-thirds the LD_{50} was delivered to 8-week-old mice, and changes in radiosensitivity were determined at various time intervals. In a second exper-

iment, adult male and female mice were given two equal doses of radiation at varying intervals up to 36 hours, and the number of nodules in the spleens were counted 10 days later. Experiments were conducted in an atmosphere of 4.2% oxygen. To establish that injury to the bone marrow was comparable when fractionated doses were used, dose-response curves were calculated. The data for these curves were obtained from the number of endogenous spleen nodules. Peripheral blood counts were also performed. Results are tabulated. Under conditions of hypoxia, initial cellular recovery in the bone marrow was absent, and proliferation was delayed. (H.L.W.)

Radiation Effects on Animals

Refer also to abstracts 419, 425, 429, 435–437, 442–448, 455, 471, 475, 484, 485, 489, 521, 523, 524, 528, 529, 533, 534, 536, 542, 546–548, and 598.

549 (AD-646667) METABOLIC CHANGES IN HUMANS FOLLOWING TOTAL-BODY IRRADIATION. Summary Report, February 1960–April 30, 1966. Saenger, Eugene L.; Friedman, Ben I.; Kereiakes, James G.; Perry, Harold (Cincinnati Univ., Ohio. Coll. of Medicine). Sept. 1, 1966. Contract DA-49-145-XZ-315. 174p. (DASA-1844). CFSTI.

Data accumulated from fifty patients who were given total or partial body irradiation at the University of Cincinnati Medical Center from February 1960 through April 1966 are reported. Psychological, hematological, metabolic, immunological and chromosomal findings are statistically analyzed and some implications concerning reduction in combat effectiveness of military personnel exposed to ionizing radiation are drawn. (TAB)

550 (AD-648028) LOCALIZED RADIOLESIONS IN THE CENTRAL NERVOUS SYSTEM. BIBLIOGRAPHY. Final Technical Report. (Uppsala Univ. (Sweden). Gustaf Werner Inst. for Nuclear Chemistry). Dec. 21, 1963. Contract AF-EOAR-62-84. 3p. (AFOSR-64-0022). CFSTI.

The bibliography lists seven reports of research conducted in the field of radiobiology and the effects of ionizing radiation on the central nervous system. (TAB)

551 (AD-648671) AN INITIAL INVESTIGATION OF THE EFFECTS OF PULSED IONIZING RADIATION ON THE PRIMATE EQUILIBRIUM FUNCTION. Report for June 1965–March 1966. Barnes, Donald J. (School of Aerospace Medicine, Brooks AFB, Tex.). Dec. 1966. 19p. (SAM-TR-66-106). CFSTI.

A Primate Equilibrium Platform (PEP) was designed and constructed in order to ascertain the effects of pulsed ionizing radiation on the equilibrium function. Twelve rhesus monkeys were trained to maintain a platform-horizontal position by the manipulation of a "joy stick." The experimental animals were transported to the Fast Burst Reactor (FBR) at White Sands Missile Range (WSMR), N. Mex., and were irradiated at that facility. The animals received an average midhead dose of 2,420 rads delivered in a microsecond pulse. Following irradiation, each animal was tested for one hour. The primary dependent variables were the time per trial spent on horizontal and the number of errors (deviations from horizontal) per trial. Results demonstrated a significant, though transient, early performance decrement. All experimental animals included in the final analysis demonstrated a recovery phenomenon subsequent to the early performance decrement. The results confirmed the equilibrium function to be relatively radiosensitive and worthy of further investigation. A modified PEP is projected for future experiments in order to more completely define the parameters of the radiation environment with respect to the equilibrium function. (auth) (TAB)

552 (COO-1669-1) STUDIES ON THE MECHANISM OF THE EFFECT OF IONIZING RADIATIONS ON THE OLFACTORY SYSTEM. Progress Report, January 1–September 1, 1967. Cooper, Gary P. (Cincinnati Univ., Ohio. Dept. of Environmental Health). Sept. 15, 1967. Contract AT(11-1)-1669. 11p. Dep. CFSTI.

In the experiments described below the response of single olfactory bulb neurons to x irradiation and beta irradiation were studied, using anesthetized rats and rabbits. In one experiment with rats the response of olfactory bulb neurons was studied in relation to the intensity and duration of x irradiation. In this study it has been shown that; the frequency of firing of an olfactory bulb neuron is a function of the logarithm of the dose rate, there is an inverse relation between the intensity and the duration of x irradiation required to bring a particular olfactory bulb neuron to a threshold state, the threshold dose for the most responsive units is about five milliroentgens, the threshold dose rate for the most responsive units is about 10 mR/sec, and the minimum response latency is no less than approximately 125 milliseconds. In work carried out on anesthetized rabbits the olfactory epithelium was exposed and the response of single olfactory bulb neurons to both x irradiation and β irradiation was studied. This work demonstrated that β irradiation of the olfactory epithelium does evoke responses of olfactory bulb neurons, whereas β irradiation of the olfactory bulb itself does not. Furthermore, the population of cells that respond to beta rays appears to be identical to that responsive to x rays. In other work in which tracheotomized rats are being used, dry air or air saturated with water vapor is being perfused through the nasal cavities of rats. Cells which respond to irradiation of the head thus far have failed to respond to irradiation of the air used to perfuse the nasal cavities. (auth)

553 (ORO-3329-3) THE EFFECT OF RADIATION ON MUCOSAL PHOSPHOLIPASE ACTIVITY. Progress Report. (Duke Univ., Durham, N. C. Dept. of Physiology and Pharmacology). Oct. 1967. Contract AT(40-1)-3329. 25p. Dep. CFSTI.

Progress is reported on studies on the effects of x radiation on the phospholipase activity of the intestinal mucosa of rats. Changes in the distribution and molecular aggregation of the enzymes during the early post-irradiation phase and the long term recovery were studied biochemically and correlated with histological changes. Methods developed for use in the studies are described and preliminary quantitative data are presented. (C.H.)

554 (UR-49-810) BIOLOGIC EFFECTS OF MICROWAVE EXPOSURE. Final Report. Michaelson, Sol M.; Thomson, Roderick A. E.; Howland, Joe W. (Rochester Univ., N. Y. Dept. of Radiation Biology and Biophysics). July 25, 1967. Contracts W-7401-eng-49; AF 30(602)-2248. 131p. Dep. CFSTI.

Animals exposed to microwaves at specific frequencies and flux densities experienced thermal stress. Duration of exposure, environmental temperature, and drugs that affect the central nervous system (CNS) and temperature regulation influenced the response of animals. High ambient temperature exaggerated the thermal response, while exposure in a cold environment prolonged the time interval for an increase in body temperature. Microwave effects on hematopoiesis, thyroid function and interaction with ionizing radiation are discussed. Sufficient data were not available to establish a comprehensive safe level for microwave exposure because of microwave frequency related factors that affect biologic response. The subtle nature of some of our findings such as modification of response to x-irradiation and effect on bone marrow and thyroid require careful evaluation. Soviet reports alluded to asthenic reactions, CNS, cardiovascular, and thyroid changes from radar exposure. The described effects were for the most part inseparable from responses that could result from thermal stress. Further knowledge of microwave hazards especially those of a subacute nature is needed to establish safety regulations. It is recommended that all microwave workers should undergo a thorough pre-employment and periodic medical examination. Persons with cardiovascular problems or lenticular defects should be considered as risks. Because of indication of bone marrow and thyroid sensitivity to microwaves, hematologic and thyroid function studies should be incorporated in the medical examination. An increase from the present maximum permissible exposure level of 10 mW/cm^2 could introduce risks that might not be readily recognized. (57 references). (B.H.S.)

555 FURTHER STUDIES ON THE EFFECT OF X-IRRADIATION ON THE HOUSE FLY, MUSCA DOMESTICA L. Rockstein, Morris; Dauer, Maxwell; Bhatnagar, Prem Lata (Univ. of Miami, Coral Gables, Fla.). Radiat. Res., 31: 840-5(Aug. 1967).

Exposure of 36- to 48-hour-old pupae of the common house fly, Musca domestica, L., to single doses of x rays ranging from 2000 to 8000 rads had no appreciable effect on the percentage of emergence or on the normal appearance of the adult flies. All levels of radiation produced only a slight but significant decline in female life span. Such low levels of x irradiation produced only a slight effect on male life span, with a decrease for 2000 rads, no effect at 4000 rads, and a slight increase at 6000 and 8000 rads. However, the effect of such x irradiation on the otherwise normally high degree of wing loss in male house flies was much more striking, the number of male house flies retaining their wings at the time of death being trebled for all four dose levels studied. In the females, there was a smaller but nevertheless significant increase in such wing retention. (auth)

556 THE EFFECT OF EXOGENOUS DNA AND OF OTHER HUMORAL FACTORS ON THE SPLEEN-NODULE COUNT AFTER WHOLE-BODY IRRADIATION. Juraskova, V.; Drasil, V. (Inst. of Biophysics, Brno). Int. J. Radiat. Biol., 11: 531-7(1966).

Using the spleen colony method we studied the effect of exogenous DNA and several other substances on the recovery of haematopoietic tissue in the spleens of x-irradiated mice. The greatest increase in the number of endogenous colonies in the spleen of irradiated animals was found when a single injection of isologous or homologous DNA was given shortly after exposure. Heterologous DNA had only a small effect. Of other substances tested heterologous milk had the greatest effect on the mean number of colonies. These results are briefly discussed. (auth)

557 STUDIES OF INTESTINAL MICROFLORA. VII. EFFECT OF DIET AND FECAL MICROBIAL FLORA ON SURVIVAL OF ANIMALS EXPOSED TO X IRRADIATION. Klainer, Albert S.; Gorbach, Sherwood; Weinstein, Louis (Tufts Univ., Boston). J. Bacteriol., 94: 383-7(Aug. 1967).

Changes in the numbers and ratios of bacteria in the feces of rats were produced by administration of three different diets: grain, meat alone, and meat plus lactose. After significant alterations in the intestinal flora developed, the animals were exposed to a midlethal dose of x radiation (1,550 R). This treatment led to 100% death in rats in which the numbers of coliforms were increased by diet prior to irradiation. Changes in the numbers of lactobacilli appeared to play no role in determining the responses to x-ray exposure. When little or no change was produced by diet and when normal microflora was present, the fatality rate was reduced to 60%; the rate of deaths was retarded when compared with that of the animals in which coliforms were increased. (auth)

558 PATHOLOGIC MORPHOLOGY OF THE PANCREAS IN EXPERIMENTAL RADIATION DISEASE IN RABBITS. Szczurek, Zbigniew (Silesian Medical Academy, Zabrge). Patol. Pol., 17: 15-24(Jan.-Mar. 1966). (In Polish).

The pancreas was studied histologically in 30 rabbits x irradiated with doses of 200 to 1000 R. The morphologic lesions seen in the pancreas included degenerative changes such as vacuolar degeneration, cloudy swelling, granular degeneration of cells, and necrosis. In the islets of Langerhans hyaline and vacuolar degeneration and necrosis of the cells was observed. The extent of the degenerative lesions was dependent on the dose of radiation and diminished with passage of time after exposure to x rays. Circulatory disorders were also noted, especially in rabbits irradiated with high doses. Proliferative changes were least pronounced, apparently unrelated to dose and increased with lapse of time. The observed changes were regarded as of a reversible inflammatory nature, which probably exerted influence on the metabolic disorders that are observed in postirradiation disease. (BBB)

559 OBSERVATIONS ON THE FINE STRUCTURE OF GIANT MAST CELLS PRODUCED BY MICROWAVE RADIATION ON THE PERITONEAL FLUID. Valtonen, Erkki J. (Univ. of Helsinki). Z. Zellforsch. Mikroskop. Anat., 80: 322-8(1967).

An electron microscopic examination of the fine structure of giant mast cells in the peritoneal fluid of the rat was made. The giant mast cells were produced by irradiating rats with a microwave apparatus generating energy of a frequency of 2425 Mcps. The most obvious features of the giant mast cell appeared to be abundant swelling of the cytoplasm, which increased the distance between the granules, and the partial disappearance of the granules. Disruption of the mast cells, with escape of the granules, was not observed. Whether the formation of the giant mast cells is a reversible process or not could not be determined on the basis of this study. (BBB)

560 THE ROLE OF INDEPENDENT AND DEPENDENT STEM CELLS IN THE CONTROL OF HEMOPOIETIC AND IMMUNOLOGIC RESPONSES. McCulloch, E. A.; Till, J. E.; Siminovitch, L. (Univ. of Toronto, Ont.). pp 61-8 of Methodological Approaches to the Study of Leukemias. Wistar Institute Symposium Monograph No. 4. Vittorio Defendi, ed. Philadelphia, Wistar Inst. Press, 1965.

Radiobiologic and other studies are reported that reveal the regulation of stem cell responses in immunity and hematopoiesis. The dissociation of the control of erythropoiesis from control of the production of other types of hemopoietic cells has been demonstrated in irradiated animals. In rats exposed to a small dose of x rays, erythropoiesis was relatively unaffected at times when stem cell activity, as measured by capacity of these cells to repopulate heavily irradiated animals, was strikingly decreased. Similarly, mice exposed to small daily doses of radiation retain the capacity to respond to erythropoietin when colony-forming capacity of their femoral marrow is reduced. Evidence for a dependent stem cell in the immunological system, based on radiobiologic studies, is also presented. Serum hemolysin levels in irradiated recipients of spleen cells transplants were used as an indicator of the growth of transplanted cells. Hemolysin-producing cells from animals immunized with foreign red cells are recognized by their capacity to produce discrete clear areas of hemolysis or plaques, when immobilized in agar containing the red cells that were used as antigen. Normal spleen cells, when transplanted into heavily irradiated recipient mice in the presence of antigen, gave rise to plaque-forming cells in the spleens of the recipients. Studies in mice bearing specific mutations affecting colony formation indicate that stem cells for the immunological system may be different from colony-forming cells. For example, mice of genotypes W/W^v and Sl/Sl^d have white fur, black eyes, reduced fertility, a severe macrocytic anemia, and increased sensitivity to the lethal effects of irradiation. Those features of the phenotype which are related to hemopoiesis, that is anemia and increased radiosensitivity, result from defects in the process of colony-formation. The increased sensitivity to radiation, which is also characteristic of both genotypes, may reflect, in part, lesions in the granulocytic and megakaryocytic portions of the colony-forming unit. No depression of the capacity of mice bearing either mutation to generate plaque-forming cells in response to antigen injection could be detected. This finding is compatible with the view that antigen-sensitive cells are not part of the potential of the unit of control dependent on hemopoietic colony-forming cells. (BBB)

561 ELECTRON OPTIC STUDIES OF CHANGES IN THE DENTAL HARD SUBSTANCE CAUSED BY LASER IRRADIATION. Vahl, Johanna; Pfefferkorn, G. (Univ., Muenster, Ger.). Deut. Zahnaerztl. Z., 22: 386-94(Feb. 1967). (In German).

The structural changes in extracted teeth caused by exposure to laser radiation were examined electron microscopically. The target zones after one, two, and three impulses with a total exit energy of two w-sec were seen as focal spots, ~0.2 mm dia. The crater was ~220 μm deep. The zone surrounding the target appearing nearly homogenous as a result of loss of structure, reflected melting processes, condensation processes, or plastic deformation of the hard substance of the tooth in micro areas. From the explosion, fissure systems were produced frequently. With the aid of so-called Q-switched procedures very sharp-edged, bizzare impact zones were caused with 40, 20, and 10 impulses, along with simultaneous morphological structural changes of the hard substance of the tooth taking place in the target zone itself. The major change in dental hard substances is attributed primarily to evaporation of the dental substance due to the high intensity impulses. Here, too, micro fissures up to a width of nine μm were observed. The surface structure of the dental enamel was lost around the target area as seen microscopically. (BBB)

562 EFFECT OF THYMUS SHIELDING ON THE BONE MARROW IN IRRADIATED GUINEA PIGS. Adams, D. (Univ. of Edinburgh). J. Anat., 99: 208-9(1965).

To determine the potentiality of thymocytes to repopulate bone marrow, 2 groups of Hartley guinea pigs were subjected to 400-R ^{60}Co γ irradiation. One group was totally irradiated, while in the other group the region of the neck containing the thymus was protected by lead shielding. The animals were killed at intervals of 1 to 14 days postirradiation, each animal receiving 1 μCi/g body weight of tritiated thymidine 24 hr prior to sacrifice. The shielded animals, after 5 days, showed higher ^3H uptake, as measured by liquid scintillation, in the femoral bone marrow, a higher proliferative rate of marrow cells measured by radioautography, and longer survival than the control group. In another group of guinea pigs, thymectomy prior to irradiation did not abolish the protective effect of neck shielding, the liquid scintillation data and the results of radioautography on bone marrow smears being almost identical to the results from the second group above. In a further series, the thymus alone was shielded by drawing it out on a vascular stalk away from the neck during the exposure. The shielded animals showed no differences in the bone marrow from totally irradiated controls. It appears that the thymus does not make a significant contribution to the recovery of marrow hemopoiesis after irradiation. (BBB)

563 REDUCED VIABILITY AMONG PROGENY OF IRRADIATED MALE RATS. McFee, A. F.; Murphree, R. L. (Univ. of Tennessee, Oak Ridge). J. Hered., 58: 37-9(Jan.-Feb. 1967).

Effects of an acute exposure of prenatal or prepubertal males on their reproductive capacity and on the viability and growth rate of their offspring were studied. Male rats were exposed at 2, 10, and 18 days of age to acute, whole-body doses of 300 R of ^{60}Co γ radiation at the rate of 6 R/min. For comparison, prenatally irradiated males from dams which had received 150-R exposures on the 17th day of pregnancy were studied. Exposure of 2-day-old rats to 300 R produced 100% sterility. Fertility at 200 days of age was not affected following exposure of 18-day-

old males but was lowered by 20% after exposure at 10 days of age. Exposure of the dam to 150 R during gestation caused a 50% reduction in fertility of her male offspring. Early postnatal deaths were significantly increased among the progeny of prepubertally irradiated males, although the growth performance of surviving offspring was not affected. The increase in postnatal deaths apparently resulted from radiation-induced genetic changes in the stem cell population of the prepubertal testis. Average body weights of the progeny of control and irradiated males showed no statistically significant differences between the weaning weights of the various groups nor in their weight gains from weaning to 63 days of age. The surviving young appeared healthy and showed no gross physical defects. (BBB)

564 CHRONIC SOLAR DERMATOSIS: A LIGHT AND ELECTRON MICROSCOPIC STUDY OF THE DERMIS. Mitchell, R. E. (Univ. of Queensland, Brisbane). J. Invest. Dermatol., 48: 203-20(Mar. 1967).

Effects of uv radiation on human skin were examined in a light and electron microscopic study of the dermis in chronic solar dermatosis. Changes in collagen, reticular and elastic fibers were seen which lead to a great reduction in the amount of organized fibrous tissue present in the dermis. Collagen fibrils, normally formed by tightly packed, strictly aligned filaments, are degraded, with the release of the filaments to form disorientated, orceinophilic masses. Reticular fibers are similarly changed. There are hypertrophy and dispersion of the elastic fibers, the orceinophilic masses being formed from both degraded collagen and altered elastin, frequently in combination. Changes in the dermal blood vessels which are described indicate that the nutrition of the dermis and epidermis may be impaired. The relation between the dermal changes of chronic solar dermatosis and cutaneous malignancy is discussed. There appeared to be little difference in the type of damage caused by long-term solar uv radiation and by long-term x radiation, although the shorter wavelengths penetrate deeper. Ultraviolet wavelengths of 3000 Å can penetrate the dermis and affect the blood vessels in the papillary layer. Although it is considered that in chronic x-ray dermatitis the dermal changes are always progressive, there is evidence that in chronic solar dermatosis such progression is not inevitable. Since solar barrier skin creams are available which will filter out the radiations of 2900 to 3100 Å, known to be harmful to the skin, an effort should be made to determine by histological, biochemical, and electron microscopic means the amount of recovery which may be expected, and the most efficient way of using such filters. (BBB)

565 TERATOGENIC EFFECTS OF RADIATION. Bishop, Paul A. (Pennsylvania Hospital, Philadelphia). Clin. Obstet. Gynecol., 9: 631-40(Sept. 1966).

Clinical and experimental evidence of mammalian in utero injury from ionizing radiation is reviewed (23 references), and prevention of such injury in clinical radiodiagnosis and therapy is commented upon. The teratogenic effects resulting from radiation of the pelvis during pregnancy probably account for only a very small percentage of the total number of malformations in the newborn, but may assume an importance in excess of their number since most can and should be prevented. Review of cases of human fetal anomalies directly attributable to therapeutic radiation during pregnancy, along with the experimental results, demonstrated that identical deformities can be produced with doses as low as 25 R if applied at a critical period of embryonic development. From day 18 to day 38, neuroblasts, that are the most sensitive of all cells, are present throughout the developing organs, and even the small amounts of radiation that reach the embryo during diagnostic studies may cause destruction of enough neuroblasts to result in minor functional disturbances of the brain or other organ systems. These disturbances may not be apparent at birth but may become evident later. Studies requiring irradiation of the pelvic area should be postponed during the first half of pregnancy and restricted during the second half unless necessary to save the life of the mother. There is no clinical or experimental evidence to indicate that preconception diagnostic radiation to the ovaries results in any somatic effects in offspring conceived at a later date. To avoid damage to an unsuspected fetus, a pregnancy test should be performed before radiotherapy is administered to the pelvis of a woman who might be pregnant. Curettage is advisable before treatment rather than relying on destruction and spontaneous abortion. (BBB)

566 SUBMICROSCOPIC OBSERVATIONS OF THE EPITHELIAL LINING OF HUMAN INTESTINAL VILLUS AFTER SMALL DOSES OF X RAYS. Gasbarrini, G.; Faggioli, F.; Chianura, G. (Univ., Bologna). Arch. Patol. Clin. Med., 42: 154-61(Dec. 1965). (In Italian).

Biopsies were obtained during radiotherapy of five patients, aged 49 to 62 yr, for carcinoma of the uterine cervix. Small samples of intestinal mucosa were taken 22 to 32 hr after administration of 100 R doses over a parametrial field of 8 × 10 cm. Electron microscopic examination of the epithelial cells revealed a fine structure that generally corresponded closely with that of unirradiated cells. However, the presence of intracytoplasmic granules, nonuniform in size, was clearly more pronounced in the irradiated cells. These granules were round or oval shaped, were surrounded by a double membrane, were sometimes lamellar in texture, and were not readily identified. They were adjacent to normal-appearing mitochondria. Also, the microvilli were more irregular in length. There was also a reduction in the number of lysosomes. The number of vesicular components in the cytoplasm of cells lining the villi was increased. It is evident that small doses of radiation, too small to produce changes visible by light microscopy, can be detected by electron microscopy. (BBB)

567 LASER INJURY IN SKIN. Kuhns, James G.; Hayes, Jude; Stein, M.; Helwig, Elson B. (Armed Forces Inst. of Pathology, Washington, D. C.). Lab. Invest., 17: 1-13(July 1967).

Acute lesions in porcine skin produced by non-Q-switched ruby laser irradiation were studied grossly and by means of a dissecting microscope, by histologic and histochemical techniques, and high-speed cinematography. Threshold doses of injury were established in pigmented and nonpigmented porcine skin. The lowest incident dose required to produce a minimal lesion of desiccation and scaling of the superficial epidermis with erythema in white pigs (in situ) was 40 J/cm^2 with a 2-msec pulse. A dose of only 2.2 J/cm^2 was required to produce a similar lesion in brown skin. More severe effects were observed in areas where the optical absorption was greatest, such as in the pigmented epidermis and hair follicles and intradermally injected pigment. These findings are in contrast to those for burns from other sources. The apparent sequence of events occurring in a severe laser lesion was as follows: absorption of the radiant energy and conversion to heat, with little conduction to adjacent tissue; thermal denaturation of tissue proteins, as evidenced by a loss of enzyme activity and alteration in connective tissue staining; explosive vaporization of tissue water; and heating of tissue, with production of gas, carbonization, incandescence, and combustion. A rapid, convenient technique is described whereby the area of enzyme inactivation from thermal denaturation was clearly delineated in fresh gross tissue. (BBB)

568 HISTOLOGICAL AND HISTOCHEMICAL ANALYSIS OF THE EFFECT ON ORAL TISSUES AND TOOTH GERMS OF IRRADIATION WITH A DEUTERON BEAM. Cabrini, R. L.; Itoiz, M. E.; Carranza, F. A. Jr.; Mayo, J.; Smolko, E. E. (Comision Nacional de Energia Atomica, Buenos Aires). Helv. Odont. Acta, 11: 124-30(Apr. 1967).

The effect of irradiation with deuteron beam doses of 100, 1000, and 10,000 Krad on oral tissues was studied in young Wistar rats using histological and histochemical methods. Histologically, degenerative lesions and destruction, particularly of dental germinal cells, were found 24 hr after irradiation with macrobeams (4 mm) at 100 Krad and over. Involution of osteoblasts and necrosis of irradiated mucosa were observed 96 hr after microbeam (100-μ dia) irradiation. Histochemically, a decrease in numerous enzyme activities proportional to the dose of irradiation was found after 24 hr. After 96 hr, enzyme activities were low, or not present in severely damaged tissues; it was high in microbially infected necrotic areas. The characteristics of primary and secondary effects of irradiation are discussed. (BBB)

569 HISTOLOGY OF THE FORMATION OF RETINAL LASER LESIONS. Marshall, J.; Mellerio, J. (Inst. of Ophthalmology, London). Exp. Eye Res., 6: 4-9(1967).

The physical processes of laser lesion formation, considered heretofore simply as heating resulting from energy absorption, or alternatively as the interaction of strong electric and magnetic fields with the molecules of the retinal tissues, were examined. The fine histology of laser-induced lesions was studied in the rabbit retina. The method used preserved the junction between the receptors and the pigment epithelium and introduced few artifacts. The lesions were made with a non-Q-switched ruby laser with between 5 and 10 mJ energy per pulse. The histological observations that are described are consistent with the theory that rapid local heating due to absorption of radiation by the epithelial pigment is the cause of a lesion. No evidence for so-called electromagnetic disruption at the point of laser beam focus was observed. (BBB)

570 LASER RADIATION. II. LONG-TERM EFFECTS OF RADIATION ON CERTAIN INTRACRANIAL STRUCTURES.

Brown, Thomas E.; True, Charles; McLaurin, Robert L.; Rockwell, R. James Jr.; Hornby, Peter (Children's Hospital Research Foundation, Cincinnati). Neurology, 17: 789-96(Aug. 1967).

Long-term clinical and pathologic studies in dogs were performed for up to one month after direct laser irradiation of the cerebral cortex, pituitary gland, and optic and oculomotor nerves. Surface-focused and convergent laser beams with energy levels from 10 to 40 J were delivered to the surgically exposed sites by a liquid nitrogen-cooled ruby pulsed laser. Results showed that neural damage caused by laser energy was irreversible and that the healing mechanism of laser-damaged neural tissue was altered because astrocytosis was delayed. Neurons were sensitive to laser irradiation effects whereas astrocytes were relatively resistant. A specific difference in cell affinity to laser energy seemed to be responsible for this, although local anoxia from the vascular damage remained a possibility. Myelinated structures (subcortical white matter, neurohypophysis, optical and oculomotor nerves) showed less injury than did highly cellular tissue (cerebral cortex, anterior hypophysis) at similar energy levels. Laser-induced damage was confined to the immediate site of impact; distant brain damage was not seen. (BBB)

571 SEROLOGIC RESPONSE OF ATOMIC BOMB SURVIVORS FOLLOWING ASIAN INFLUENZA VACCINATION. Morita, Katsuhiko (Sapporo Medical Coll., Japan). Sapporo Igaku Zasshi, 29: 63-74(Jan.-Feb. 1966). (In Japanese).

The effect of exposure to atomic bomb radiation on antibody production was studied in persons living in 1961 who were exposed while in utero or during the first 2 yr of life in either Hiroshima or Nagasaki. The subjects were inoculated with Asian influenza vaccine, then the correlation between production of complement-fixing antibody to various types of influenza A virus and distance from the hypocenter was attempted. Prevaccination antibody levels of both in utero and postnatally exposed subjects beyond 3000 m were the highest against A1 type virus. Similarly, post-vaccination antibody levels of the groups were the highest against the virus among those tested except for the Asian type. Significantly reduced A1 antibody levels were noted in the proximally in utero exposed subjects of Nagasaki. Reduction of this type of antibody was also noted in the proximally exposed-after-birth group in both cities. In the in utero group of Hiroshima, Asian influenza antibody levels were markedly higher in those proximally exposed. Heterotypic response of A1 type antibody following Asian influenza vaccination was significantly suppressed in the proximally in utero exposed subjects of both cities. In contrast, homotypical Asian antibody response was enhanced in those subjects in comparison to controls. Development of acute radiation symptoms could be related to antibody levels of the postnatal group even in subjects at the same distance. The effect was most marked for antibody levels to Weiss virus. The results suggest that suppression of antibody production on account of radiation exposure persisted considerably longer than that expected from animal experiments. Reasons for such a long duration of the suppression were discussed. (BBB)

572 THE RESPONSE OF PIG SKIN TO FRACTIONATED TREATMENTS WITH FAST NEUTRONS AND X RAYS. Bewley, D. K.; Field, S. B.; Morgan, R. L.; Page, B. C.; Parnell, C. J. (Hammersmith Hospital, London). Brit. J. Radiol., 40: 765-70(Oct. 1967).

The skin of pigs has been used to study the effect of fractionated irradiation with fast neutrons of mean energy 6 MeV. Six, nine and 15 fractions have been used over a period of three weeks, and two fractions divided by short intervals of time up to 24 hours. The effects of fractionated treatments with x rays are also summarized. The RBE of the neutron beam rises steadily from 2.3 for a single dose to 3.6 for 15 fractions. Observations up to five years after treatment have failed to show any sign of increased late reactions after neutrons. There is less recovery during a fractionated course of treatment with fast neutrons than with x rays, the relative amount of recovery being 0.6. Very little recovery was observed during the first seven hours after treatment with neutrons. Reactions occurring after fractionated treatments with x rays show that the number of fractions is more important than the time over which the treatment is extended, up to 28 days, but that prolongation is nevertheless a significant factor. (auth)

573 STUDY OF THE GROWTH AND MIGRATION RATE OF IN VITRO CULTURED MYOBLASTS EXPLANTED FROM CHICKEN EMBRYOS AFTER X IRRADIATION WITH LETHAL DOSES. Maggi, C. A.; Malaspina, A. (Univ., Palermo, Italy). Med. Nucl. Radiol. Lat., 9: 359-89(1966). (In Italian).

In vitro culture methods were used to study the effects of x radiation on the myocardium of chicken embryos irradiated at the 7th day of incubation. The heart was used to prepare the culture immediately after irradiation, six hours after irradiation, and three hours after the natural death of the embryo following the irradiation. The growth rate of the culture was carefully controlled and every 24 hours the ratio of the migration area to the mean value of the internal and external perimeter of the area itself was calculated. Each explant was allowed to grow from 5 to 7 days and then two subcultures were prepared. The results demonstrate that the explants after irradiation with 502,000 rad grow more slowly until the fourth transplantation, when their growth becomes normal; the explants from the myocardium of embryos still living after 6 hours after the irradiation with 500 to 1000 rad grow still slower and the growth stops at the 7th to 8th transplantation; the explants of myocardium of embryos dead three hours after irradiation of 502,000 rad have poor growth and stop growing at the third transplantation. It was concluded that the pattern of growth of a culture of myoblasts from an explant of myocardium of irradiated chicken embryo depends partly on the radiation doses, but mainly on the time elapsed between irradiation and implantation of the culture. (auth)

574 EFFECT OF TOTAL-BRAIN IRRADIATION ON CEREBROSPINAL FLUID PRESSURE. Redmond, D. E. Jr.; Rinderknecht, R. H.; Hudgins, P. T. (Baylor Univ., Houston, Texas). Radiology, 89: 727-32(Oct. 1967).

Brain irradiation was assumed to cause cerebrospinal fluid hypertension. The present study was undertaken to determine the effect of total-brain irradiation on cerebrospinal fluid pressure. Twenty mongrel dogs were prepared with subarachnoid catheters and irradiated with single doses of 1,000, 2,000, or 4,000 R. CSF pressures were measured daily for fourteen days after irradiation. No statistically significant pressure increases occurred in any of the groups. Apparently the normal mechanisms for maintaining CSF pressures were adequate in these animals to compensate for any radiation-induced changes in CSF secretion, resorption, or intracranial volume. (auth)

575 FUNCTIONAL STATE OF CELLS OF THE ENCEPHALIC CORTEX OF RATS PRENATALLY SUBJECTED TO IRRADIATION. Shlyafer, T. P. (Inst. of Experimental Medicine, Moscow). Dokl. Akad. Nauk SSSR, 175: 502-4(July 11, 1967). (In Russian).

The functional state of individual neurons of the cerebral cortex was studied in rats exposed to 100 R of x radiation on the 10th day of their embryonic development. The experiments were carried out with 108 cortex cells in control rats and 64 cortex cells of antenatally irradiated animals. Microelectrode studies were made on 2½ month old antenatally irradiated rats. The recording of potentials of individual neurons in various layers of the cerebral cortex in the control and antenatally irradiated rats showed spontaneous pulsation–background activity. The number of spontaneously active cells was larger in the controls (average 6 to 8 cells) than in the irradiated animals (3 to 4 cells). Data indicated that the functional mobility of cerebral cortex cells in antenatally irradiated rats was lower than in control rats. The changes in the activity of individual neurons in irradiated rats were expressed by less spontaneous activity of the cortex cells, lower frequency of cortex background pulsations, and smaller numbers of cortex cells reacting to the stimulants used. It was postulated that the observed activities were caused by the disturbance of afferentation, blood supply, and metabolism. (R.V.J.)

576 EFFECTS OF CONTINUOUS LOW-LEVEL GAMMA IRRADIATION ON CIRCULATING AND PERITONEAL MONONUCLEAR LEUKOCYTES OF MICE. Kornfeld, Lottie; Greenman, Vivian (Naval Radiological Defense Lab., San Francisco). Radiat. Res., 31: 889-95(Aug. 1967).

LAF_1 mice were exposed continuously to ^{60}Co γ-radiations at a dose rate of 1.4 rads per hour. The number of lymphocytes in the circulating blood fell sharply during the first week of exposure (190 rads) and decreased thereafter at a very gradual but statistically significant rate for the duration of the experiment (15 weeks, 3450 rads). The disappearance of small lymphocytes (6 microns in diameter) from the peritoneal cavity was also more rapid during the first week of irradiation than during subsequent weeks. Medium peritoneal lymphocytes (8 to 10 microns in diameter) and peritoneal macrophages disappeared at constant rates over the entire observation period. After the first week of exposure, the disappearance rates of small and medium peritoneal lymphocytes were identical. This rate was greater than that for peritoneal macrophages or that for circulating lymphocytes. Based on the fraction of cells surviving any given exposure, the mononuclear leukocytes may be arranged in the following order of decreasing sensitivity to continuous low-dose-rate γ-irradiation: circulating lymphocytes, small peritoneal lymphocytes, medium peritoneal lymphocytes, peritoneal macrophages. This order is the same as that after acute exposure to x-rays. (auth)

577 RESPONSE OF ERYTHROPOIETIC STEM CELLS OF MICE TO IRRADIATION WITH FISSION NEUTRONS. Krebs, John S. (Naval Radiological Defense Lab., San Francisco). Radiat. Res., 31: 796-807(Aug. 1967).

The destruction of erythropoietic stem cells by irradiation with fission neutrons was studied in plethoric C57 laden male mice by measuring the incorporation of ^{59}Fe into erythrocytes 48 hours after a dose of erythropoietin. The survival of stem cells in mice exposed to single doses of neutrons at 37 rads/min followed the single-hit multitarget model of radiation injury to cells: $S/S_0 = 1 - [1 - \exp(-D/D_0)]^E$, where S/S_0 is survival fraction, D is dose, D_0 is 37% dose, and E is target multiplicity. The value of D_0 was a constant, equal to 27.8 rads for all animals, but E varied from 1 to 4 different animals. The survival of stem cells in mice exposed to single doses of neutrons at 1.75 rads/min followed the single-hit multitarget model, with $D_0 = 26$ rads, for those animals for which $E = 1$, but animals with $E > 1$ did not fit the model. The survival of stem cells in mice exposed to three doses at 37 rads/min at intervals of 10 to 12 hours also followed the single-hit multitarget model, with mean $D_0 = 26$ rads, and a distribution of values of E similar to that in the single dose. The data strongly imply that the loss of stem cells follows the multitarget model, but that E, instead of being a constant, is a basic biological variable of the response. (auth)

578 MECHANISM OF HEMATOPOIETIC RECOVERY IN THE X-IRRADIATED MOUSE WITH SPLEEN OR ONE LEG SHIELDED. Fujioka, Seitoku (National Inst. of Radiological Sciences, Chiba, Japan); Hirashima, Kunitake; Kumatori, Toshiyuki; Takaku, Fumimaro; Nakao, Kiku. Radiat. Res., 31: 826-39 (Aug. 1967).

Mice with spleen or one leg shielded were given 600 R of x irradiation, and the mechanism of hematopoietic recovery was studied on the basis of ^{59}Fe uptake in the organ, histological observation, and stem cell kinetics. Whole-body irradiated mice served as controls. After irradiation, hematopoietic recovery in the exposed organ (spleen or femur) of the experimental animals took place earlier than in the controls. In the experimental animals, hematopoiesis in the exposed femur increased significantly within 10 days after irradiation, whereas hematopoietic activity in the shielded one decreased during the same period. The inverse course between the exposed organ and the shielded one was also demonstrated on the level of the stem cell, that is, erythropoietin-responsive cells and colony-forming cells. These facts suggest that stem cells in the shielded organ migrate into the exposed one, where they proliferate and differentiate so intensively as to make a contribution to early hematopoietic recovery. (auth)

579 FAILURE OF 1100 RADS OF X-RADIATION TO AFFECT CILIOGENESIS AND CENTRIOLAR FORMATION IN CULTURED RAT LUNGS. Sorokin, S. P.; Adelstein, S. J. (Harvard Medical School, Boston). Radiat. Res., 31: 748-59 (Aug. 1967).

The development of both rudimentary cilia and the ciliated epithelial border has been studied in organ cultures of rat lungs that have absorbed 1100 rads of x radiation 24 hours after explantation. The radiation was administered 1 to 5 days before the appearance of the earliest precursors. No delay was observed in the appearance of the ciliated border, and no reduction in the number of cilia was seen in the irradiated cultures as compared to controls. Electron micrographs demonstrated that ciliogenesis proceeded normally both from centrioles present at the time of irradiation (rudimentary cilia) and from basal bodies still unformed when the x rays were given (the ciliated border). Apparently basal body formation and maturation progress normally even though the cell is irradiated with a dose that leads to proliferative failure. (auth)

580 EFFECTS OF WHOLE-BODY IRRADIATION ON A SMALL SOUTH AMERICAN PRIMATE, SAGUINUS FUSCICOLLIS. Gengozian, N.; Batson, J. S. (Oak Ridge Inst. of Nuclear Studies, Tenn.). Contract AF 41(657)-398. Int. J. Radiat. Biol., 11: 539-51(1966).

Whole-body γ radiation exposure (^{137}Cs) of marmosets, small South American primates, suggests a 30-day LD_{50} of 200 R. Hematological studies after irradiation showed a marked sensitivity for all parameters, with a slow and often incomplete recovery in animals which received only 100 R and 200 R. Immunological suppression was only temporary, even in animals exposed to an LD_{100} dose of 400 R, and recovery was complete in the 100 R and 200 R animals within two weeks after irradiation. At necropsy parasitism was observed in several of the marmosets; the acanthocephalan, Prosthenorchis elegans, was the most prevalent. Comparisons of the data in this study with previous reports on radiation effects in the rhesus, Macaca mulatta, indicates a greater reaction of the marmoset to radiation. Possible causes of the apparent radiosensitivity of the marmoset have been considered, particularly factors such as parasitism, unknown age of the animals, viral infections, and the blood chimaerism that exists naturally in these primates. (auth)

581 THE REDUCTION OF AORTIC AND ILIAC LYMPH NODES WITH MALIGNANT LYMPHOGRANULOMATOSIS BY ^{60}Co DEPTH IRRADIATION. Renemann, H.; Boutis, L.; Musshoff, K.; Weissleder, H. (Medizinische Univ., Freiburg i. B.). Fortschr. Geb. Roentgenstr. Nuklearmed., 107: 345-52(Sept. 1967). (In German).

Measurements were carried out on 94 iliac and aortic lymph nodes that were demonstrated lymphographically in patients with lymphogranulomatosis before and after irradiation with ^{60}Co, using between 3,400 and 4,200 R. The reduction in length averaged 21.2% and in width 36.5%, the difference being statistically significant. There was greater reduction in nodes measuring less than 20 mm than in nodes measuring more than 20 mm following high voltage therapy. The cause for the difference in changes in longitudinal and lateral measurements during therapy was thought to lie in the arrangement of the lymphoid tissue and the stroma. The reduction in lymph node size among nodes that were little affected was ten percent less than among the others. The calculated volume reduction of lymph nodes under therapy did not correlate with the radiation dose of 3,400 to 4,200 R, nor to the duration of treatment that varied from 23 to 93 days. (auth)

582 THE RBE OF GAMMA-RAYS AND FISSION NEUTRONS FOR ACUTE AND SUB-ACUTE EFFECTS IN IRRADIATED RABBITS. Batchelor, A. L.; Horne, A. W.; Hulse, E. V.; Stuart, C. E. (Medical Research Council, Harwell, Eng.). Int. J. Radiat. Biol., 11: 583-91(1966).

Rabbits were given acute whole-body irradiation with either neutrons (mean energy 0.7 MeV, dose range 400 to 1500 rads) or gamma rays (mean energy 2.5 MeV, dose range 1000 to 3000 R). The last acute death was at 32 days and the LD50/32 was 572 rads for neutrons and 1389 R for gamma rays, giving an RBE of 2.4. Acute deaths were primarily due to hemopoietic failure, but damage to the alimentary tract probably also played a part. Coprophagia (reingestion), which is normal in rabbits, may have increased the liability to post-irradiation infection. Sub-acute lesions, between 2 and 7 months after irradiation, occurred only after exposure to neutrons and not after gamma-rays. Just over half were local lesions of limbs, related to the entry dose of neutrons, and the remainder were intrathoracic effusions. When these sub-acute effects were taken into account the RBE rose to 3.0. (auth)

583 ELECTROENCEPHALOGRAPHICAL AND MORPHOLOGICAL INVESTIGATION UPON THE INFLUENCE OF MICROWAVES ON THE CENTRAL NERVOUS SYSTEM. Baranski, Stanislaw; Edelwejn, Zbigniew. Acta Physiol. Pol., 18: 517-32 (July-Aug. 1967). (In Polish).

A series of electroencephalographic and morphologic investigations upon the influence of microwave irradiation on the central nervous system of rabbits was carried out. Male rabbits with screw electrodes inserted into the skull were used. These made possible the registration of bioelectric activity from premotor, sensory-motor and optic areas of the brain. The experiments were performed in two groups. In group I the animals were exposed to the influence of a pulsed and continuous microwave field of 10 cm and 3 cm bands by means of constant power density (5–7 mW/cm^2). The experiments lasted for 60 days (3 hours daily). In group II, the influence of single irradiation by pulsing of the continuous waves of 10 cm band, and 3 cm band pulsed waves was observed. The irradiation began at 5 mW/cm^2 power density and the power was gradually increased to 30 mW/cm^2. The results showed that the most distinct changes in the central nervous system were observed in both groups irradiated by means of 10 pulsed waves. (auth)

584 INCREASED RESISTANCE TO UHF IRRADIATION UNDER CONDITIONS OF SYSTEMATIC MUSCULAR ACTIVITY. Petrov, I. R.; Yarokhno, N. Ya. Voenno-Med. Zh., No. 4, 20-1 (Apr. 1967). (In Russian).

The role of systematic muscular activity and isotonic exercise in raising resistance to UHF irradiation was studied in three series of 20 experiments on white mice. Trained and untrained white mice were exposed to UHF irradiation ($\lambda = 12.6$ cm, density = 34 mw/cm^2) from a Luch-58 apparatus for 20 min. Series I mice were untrained (controls); series II mice were given physical training for 15 days prior to irradiation. They were made to swim for 30 min twice daily for 5 days, and for 45 min twice daily for 10 days.) Series III mice were prepared with isotonic exercise. (They were made to cling to a bar twice daily for 5 min on the first day, 10 min for the next 6 days, and 45 min for the next 11 days.) Mortality following irradiation was 16 out of 20 for Series I (controls), 3 out of 20 for Series II (swimming), and 8 out of 20 for Series III (isotonic exercise). The increased resistance to UHF was still

evident in Series II mice irradiated for a second time 10 days later (shown by a mortality of 4 out of 10). By 20 to 25 days after training had ceased, resistance (and mortality) of the trained mice was the same as for the controls. By stimulating nonspecific adaptive reactions of the organism, physical exercise enhanced resistance to a variety of harmful factors (hypoxemia, hyperthermia, infection), including UHF irradiation. (ATD)

585 PROBLEM OF CLINICAL OBSERVATION OF INJURIES CAUSED BY SHF ELECTROMAGNETIC FIELDS. Kolesnik, F. A.; Malyshev, V. M. Voenno-Med. Zh., No. 4, 21-3 (Apr. 1967). (In Russian).

A clinical description is given of two cases of severe injury by SHF irradiation, one resulting from exposure to a medium-intensity field and the other from exposure to a low-intensity field. The first patient was accidently exposed to 3-cm waves with an intensity of 15 mw/cm^2 for 45 to 47 min (maximum permissible exposures are 2 hr for intensities of 0.1 mw/cm^2, 20 min for 1 mw/cm^2). Immediately following exposure the patient complained of headache, dizziness, general debility, nausea, trembling, tachycardia, cold sweat, sharp pain in the eyes, and epistaxis. Peripheral blood taken that day showed neutrophil leukocytosis (16,000 count). First aid (valerian with bromine, IV camphor and caffeine, arrested nosebleed) made the patient more comfortable but failed to relieve the basic symptoms. Clinical examination revealed labile pulse (fluctuating from 76 to 92 beats/min at rest) and blood pressure of 150/90. Prothrombin time increased to 250 sec (from a norm of 110 to 120 sec). Cholesterine activity was 224 mg%, and serum cholinesterase activity was 6.5 mm. The EEG showed no reaction to light and sound stimuli; the EKG revealed paroxysmal tachycardia. The latter was the most persistent symptom; attacks lasted 2 to 3 days and even 5 to 7 days, and continued to occur at intervals until the 40th day of hospitalization. Complex treatment was given (intensive sedation and reinforcement therapy, novacainamide, reserpine, and symptomatic drugs). The patient was discharged on the 45th day and was to be followed as an outpatient. Further work near microwave generators was forbidden. The second patient was accidentally exposed to 3-cm waves with an intensity of 15 to 20 mw/cm^2 for 10 to 15 min. Only the head and upper trunk were exposed. The patient complained of weakness, headache, visual disturbances (could not read). He was hospitalized on the third day after exposure. Pulse was 64 beats/min and steady; blood pressure was 120/80. The EEG revealed lowered voltage, a rapid beta-rhythm, and a slow theta-rhythm; the EKG showed sinus bradycardia. Prothrombin time was 120 sec. A diagnosis of asthenic syndrome with autonomic dysfunction following SHF irradiation was made. Treatment was identical with that given the first patient described. By the 10th day of hospitalization all symptoms had disappeared, and the patient was discharged. Outpatient observation showed that functional disturbances of the nervous system persisted for about a year in some form or another. (ATD)

Radiation Effects on Plants

Refer also to abstracts 477–480 and 482.

586 GENETIC CONTROL OF RADIATION SENSITIVITY IN YEAST. Puglisi, P. P. (Univ., Parma, Italy). Radiat. Res., 31: 856-66(Aug. 1967).

A strain of Saccharomyces cerevisiae (FF53/b) showing an abnormal survival curve to x radiation is described. It is derived from a normal haploid parent and is killed exponentially by x rays without showing the tail due to the phenotypically resistant fraction of cells normally found in any yeast culture. The genetic analysis has shown that strain FF53/b is an autodiploid that has lost the initial shoulder of radioresistance typical of diploid strains. This abnormal behavior is due to a single dominant genetic factor that is probably lethal in haploid conditions. (auth)

587 EFFECT OF GAMMA RADIATION ON THE NUCLEAR VOLUME OF CELLS OF PRIMARY ROOTS OF WHEAT. Fursov, V. I.; Autenshlyus, A. I. Vestn. Sel'skokhoz. Nauki, Min. Sel. Khoz. SSSR, No. 6, 82-6(June 1967). (In Russian).

Ionizing radiations at doses from 800 to 2500 R in oxygen medium and in normal atmosphere caused profound changes in the cytomorphological structure of the cells and suppressed the nuclear volume in the meristem of the primary root of wheat. The most substantial changes in the structure and cytochemical organization of the meristem were observed during irradiation of the seeds in oxygen medium. The change of the spectrum of the complex DNA–AO of the plants tested indicates a quantitative decrease in the DNA content. (tr-auth)

588 THE GAMMA-RAYS ^{60}Co EFFECT ON PHOTOSYNTHESIS INTENSITY OF SOME HIGHER PLANTS. Marfina, K. G.; Ibragimov, A. P. (Inst. of Zoology and Parasitology, Tashkent). Uzb. Biol. Zh., No. 4, 7-9(1967). (In Russian).

Maize seeds were given 500 to 1000 R and cotton seeds 1000 to 3000 R doses of gamma radiation. The intensity of photosynthesis in plants developing from irradiated seeds was increased. (H.L.W.)

Radiation Effects on Microorganisms

Refer also to abstracts 428, 432, 476, 483, and 519.

589 INFLUENCE OF TEMPERATURE DURING THE UV IRRADIATION INACTIVATION AND MUTATION OF SERRATIA MARCESCENS AND THE BACTERIOPHAGE KAPPA. Hainz, H.; Kaplan, R. W. (Univ., Frankfurt am Main). Z. Allg. Mikrobiol., 3: 113-25(1963). (In German).

The number of color mutants produced by exposure of Serratia to temperatures from 40 to 60°C was increased. The inactivation of Serratia by uv irradiation was relatively constant between temperatures of –20 to +45°C, but below this range between –25 to –55°C inactivation increased greatly with survivals of from 10^{-2} to 10^{-4} at –50°C. These results indicated that the irradiation inactivation effects probably were not indirectly mediated by diffusion of energetic molecules, but may have been related to chemical structural changes. Dehydration of the cells also enhanced uv inactivation. The color mutation rate decreased slightly between +2°C and –50°C, suggesting that the uv lesions (premutations) leading to color mutations were different from those that caused changes in the reproductive characteristics. Water addition products of cystosine may be the primary factor that caused the mutations. Increased scattering of the uv irradiation by formation of ice crystals within the cells at low temperatures also may have been a factor that decreased the uv mutation effects. Inactivation and mutability of the bacteriophage Kappa was not markedly affected by temperature changes between +45 and –55°C. The phage was somewhat inactivated at 60°C, with a survival of 10^{-4}, but no mutations were observed. (BBB)

590 RADIATION SENSITIVITY OF CERTAIN BACTERIOPHAGES. Gabrilovich, I. M.; Lukel'eva, S. I. (Belorussian State Univ., Minsk). Microbiology (USSR) (Engl. Transl.), 29: 108-11(Jan.-Feb. 1966).

The inactivating action of ^{60}Co γ radiation on 18 phages active against certain species of bacteria belonging to the family Enterobacteriaceae was studied. The 9 E. coli phages tested could be divided into 4 groups with respect to γ-radiation sensitivity. The most sensitive were the T-even E. coli phages, the second group consisted of T3 and T7 phages, and the third comprised phage T1. Thus the T phages, belonging to different serological groups, had different radiosensitivities. The most stable were phages ϕX174, f2, and MS-2. All these phages differed in size, the amount, type, structure, and composition of nucleic acid. T-even phages are bigger and contain 2 to 2.5×10^{-16} g of DNA per particle. The DNA of these phages is double-stranded and the cytosine in it is substituted by 5-oxymethylcytosine. Odd phages of the T group are smaller and contain double-stranded DNA. Phages most stable against γ irradiation differed from phages of the T group in still other respects. Phage ϕX174 contains single-stranded DNA while phages f2 and MS-2 contain RNA. These three phages are equal in size and contain 2.6 to 3×10^{-18} g of nucleic acid per particle. Inactivation of these phages by γ irradiation was practically identical. No marked differences were noted in radiosensitivity of single-stranded DNA and RNA phages. Nine Klebsiella phages were studied. Their sensitivity to γ radiation was closely related to that of ϕX174 and RNA phages, as well as to T1, T3, and T7 E. coli phages. Three Klebsiella phages with comparatively low radiosensitivity are described. (BBB)

591 CONDITIONS AFFECTING THE EARLY THYMINELESS DEATH OCCURRING AFTER ULTRAVIOLET IRRADIATION OF ESCHERICHIA COLI B3. Painter, Robert B.; Rasmussen, Ronald E. (Ames Research Center, Moffett Field, Calif.). Photochem. Photobiol., 4: 61-5(Jan. 1965).

The early thymineless death occurring after uv light irradiation of E. coli B3 can be partially reversed by exposure to photoreactivating light. A mechanism occurs in E. coli whereby damaged areas of DNA, containing thymine dimers, are excised from chromosome. Presumably, repair of this excision occurs by a process involving the resynthesis of the area, including the thymine moieties. An obvious explanation of uv-induced early thymineless death would be that the lack of thymine renders the repair mechanism inoperative and those cells, which, in the presence of thymine would have repaired the damage and survived, die. Results are reported that are not inconsistent with

this concept, but indicate that components of the cell other than DNA are important in the expression of early thymineless death. Thus, exposure of the thymine-requiring strain B3 to uv prior to incubation in the absence of thymine shortened the lag period normally observed before the onset of death due to lack of thymine. Culture conditions promoting synthesis of new kinds of enzymes at the time of thymineless challenge after uv irradiation enhanced this effect. The effect could be reversed either by the addition of thymine or photoreactivation. Possible mechanisms for these phenomena are discussed. (BBB)

592 A STUDY OF RADIOSENSITIVE AND RADIORESISTANT MUTANTS OF ESCHERICHIA COLI STRAIN B. Hill, Ruth F.; Simson, Eva (Columbia Univ., New York). J. Gen. Microbiol., 24: 1-14(1961).

Relative differences in radiosensitivity between Escherichia coli strain B and the mutant strains, B/r (more resistant than B) and 2 types of B_S (more sensitive), were maintained with respect to inactivation by uv radiation, x rays, and decay of incorporated ^{32}P. The differences could not be ascribed to variations in number of nuclei or in content of DNA or RNA. The effectiveness of various postirradiation and postdecay treatments in preventing inactivation varied for each strain. With the exception of reactivation by light, strain B/r was less reactivable than B and B_S. The strains did not differ in their rates of mutation to resistance to bacteriophage T_1. However, the rates of mutation of the B_S mutants to the first step of furacin-resistance were considerably lower than the rate for the parent strain B. From one of the B_S mutants, new strains were obtained whose properties were mixtures of those of B and B/r. (BBB)

593 PHAGE: HOST RELATIONSHIPS IN CERTAIN STRAINS OF CORYNEBACTERIUM DIPTHERIAE. Miller, Pauline A.; Pappenheimer, A. M. Jr.; Doolittle, W. Ford (Harvard Univ., Cambridge, Mass.). Virology, 29: 410-25(July 1966).

From the C. diphtheriae strain P60(β) that is lysogenic and toxinogenic, defectively lysogenic mutants that maintain their toxinogenicity were isolated. Properties of one such P60(βdf) mutant were studied and compared with those of normal lysogenic strains, and with those of the classic high toxin-producing PW8 strain. When strain P60(βdf) was irradiated with uv, one or two infectious centers per 5×10^7 induced cells were obtained as a result of back mutation to P60(β). The particulate material released from the uv irradiated culture was similar in yield and in serological properties to normal β phage released from P60(β) following uv induction. Like normal phage, βdf was adsorbed readily by suspensions of the sensitive C7(–) strain. The uv irradiated cultures of the PW8 strain also released an occasional plaque-forming particle (roughly one infectious center per 10^7 organisms induced) from which a phage indistinguishable from β phage could be isolated. (BBB)

594 COMBINED ACTION OF DIPHENYL AND GAMMA RADIATION ON THE IN VITRO DEVELOPMENT OF FUNGI PATHOGENIC TO CITRUS FRUITS. Barkai-Golan, Rivka; Kahan, R. S. (Volcani Inst. of Agricultural Research, Rehovot, Israel). Phytopathology, 57: 696-8(July 1967).

The combined action of diphenyl and a sublethal dose (60 Krad) of ^{60}Co γ radiation completely inhibited the growth of Penicillium digitatum and Diplodia natalensis, and the combined action of diphenyl and 140 Krad inhibited growth of Penicillium italicum. These 3 species were the most sensitive to diphenyl of those tested. Growth of Trichoderma viride, which is diphenyl resistant but radiosensitive, was completely inhibited by a combined treatment of diphenyl and 60 Krad. A dose of 60 Krad by itself caused only a marked growth retardation. The quantity of diphenyl in these combined treatments could be reduced to 5 mg/dish without reducing its effectiveness. The combined action of diphenyl and radiation on Phytophthora citrophthora, Oospora citri-aurantii, Colletotrichum gloeosporioides, and Alternaria citri had no increased effects over those of the treatments when tested separately. (BBB)

595 THE STUDY OF VESICULAR STOMATITIS VIRAL COMPONENTS BY X IRRADIATION. Warrington, R. E. (Animal Virus Research Inst., Pirbright, Eng.). Arch. Gesam. Virusforsch., 19: 442-53(1966).

Direct and indirect effects of x irradiation of vesicular stomatitis virus were studied. The inactivation of viruses by the direct effect of x irradiation was used to obtain a value for the sensitive volume. Inactivation of virus by the indirect effect was performed in a similar way, except that the peptone concentration of the suspension medium was reduced to 1 mg/100 ml. At this concentration, any inactivation due to long-lived radicals was negligible, so that only short-lived radicals could cause inactivation. Velocity sedimentation in sucrose density gradients was used to separate and study the biologically active components of the virus grown in baby hamster kidney cells (VSV-BHK) and chick embryos (VSV-CE). If the main infective component in VSV-CE was given a sedimentation coefficient of 625S, then another infective component of about 500S was isolated by preferentially inactivating the main component with x rays. The progeny from this after a single passage in BHK cells sedimented at about 750S and continued to do so after many similar passages. The 750S component was found to be more resistant to heat inactivation at 37°C than either the 625S or 500S components. The 625S component was neutralized more efficiently with sp antiserum than either of the other 2 components. Both the 750S and 500S components had buoyant densities of 1.22 mg/ml in CsCl. (BBB)

596 MECHANISM OF PHOTOINACTIVATION OF COLIPHAGE T7 SENSITIZED BY ACRIDINE ORANGE. Freifelder, David (Brandeis Univ., Waltham, Mass.); Uretz, Robert B. Virology, 30: 97-103(Sept. 1966).

Results of photoinactivation experiments performed with visible light in the presence of a photosensitizing dye were compared with those obtained with uv and x irradiation. A chemical lesion produced by visible light irradiation of Escherichia coli phage T7 sensitized by acridine orange (AO) was detected by ultracentrifugal analysis. The irradiated DNA contained a new bond that is alkali labile and insensitive to short periods of heating. Evidently a nucleotide base was photochemically changed so that either it had a labile N-glycosidic bond or was removed from the DNA leaving a gap in the base sequence. Since the survival of E. coli B and B_{S-1} was the same, and since B_{S-1}, B, and B/r are inactivated at the same rate and there are no effects of various postirradiation treatments, it is suggested that the lesions are not repairable by the same mechanisms responsible for recovery from uv or x rays. (BBB)

597 RADIATION INJURY AND PROTECTION OF SINGLE-STRANDED RNA AND DNA BACTERIOPHAGES. Vinetskii, Yu. P. (Inst. of Biophysics, Moscow). Microbiology (USSR) (Engl. Transl.), 35: 860-2(Nov.-Dec. 1966).

Attempts were made to assess the direct and indirect effect of γ radiation on bacteriophage with different types of nucleic acid. Irradiations were carried out so that the indirect action of ionizing radiation predominated, injury of the virus particles owing to the action of highly reactive substances formed in the medium. The study was conducted on the DNA-containing phage ϕX174 and RNA-containing phage MS2, acting on Escherichia coli C and E. coli HfrF, respectively. Phagolyzates were γ irradiated under aerobic conditions in buffer solution (0.1M NaCl and 0.033M phosphate buffer, pH 6.8 to 7.2) at a dose rate of 140 R/sec. Cysteamine was dissolved in phage suspensions within one hr before irradiation. Results showed that for irradiation under conditions demonstrating the indirect action of radiation, the D_{37} for phage ϕX174 was 31 KR, and for phage MS2, 12 KR. In the irradiation of ϕX174, a deviation from a one-hit law was observed, while for phage MS2 there was a conservation of the one-hit character of the inactivation curve. A MS2 phage particle contains relatively less nucleic acid. The molecular weight of the RNA is $\sim 1.5 \times 10^6$, whereas the DNA of phage ϕX174 has a molecular weight of 1.7 to 1.8×10^6. From a comparison of the values of D_{37} obtained, it is evident that no correlation between the nucleic acid content and the radiosensitivity was observed in these viruses when the irradiation was conducted in buffer. Moreover, the RNA-containing phage MS2 with a smaller amount of nucleic acid was found to be more radiosensitive to the indirect action of radiation than phage ϕX174. (BBB)

598 INTERFERON SYNTHESIS IN X-IRRADIATED ANIMALS. I. DEPRESSION OF CIRCULATING INTERFERON IN C_3H MICE AFTER WHOLE-BODY IRRADIATION. Jullien, Pierre; De Maeyer, Edward (Institut du Radium, Biologie, Orsay, France). Int. J. Radiat. Biol., 11: 567-76(1966).

The production of circulating interferon in x-irradiated (1000 R, whole-body) C_3H/He mice was studied. In the irradiated animals, the amounts of interferon released into the circulation after injection of either Newcastle Disease virus or Sindbis virus were reduced to about 20 per cent of control values. The inhibitory effect of the x irradiation appeared during the first 24 hours after irradiation, when Sindbis virus was used as an inducer of interferon formation; with Newcastle disease virus as inducer, interferon levels remained normal up to 48 hours after irradiation. This suggests that a different cell population is involved for each of these two viruses. (auth)

Radiosterilization and Radiopreservation

Refer also to abstract 210.

599 (LS-173) RADIATION PRESERVATION OF FOODSTUFFS: A SELECTED ANNOTATED BIBLIOGRAPHY. Kahan, R. S. (Israel Atomic Energy Commission, Yavne. Soreq Nuclear Research Center). June 1967. 66p. Dep.

A selected bibliography covering the literature until June 1964 is presented. The bibliography deals mainly with radiopasteurization (radurization) of fruits and vegetables and inhibition of sprouting. It includes 284 references. (auth)

600 STERILIZATION OF SALINE BY GAMMA RADIATION. Ogg, A. J. Proc. Roy. Soc. Med., 60: 357(Apr. 1967).

A method for radiosterilization of physiological salt solution used in opthalmology is reported. Ideally saline for anterior chamber irrigation should be sterilized, stored, and utilized in one sealed container. Only by radiosterilization could this be achieved. Polystyrene syringes (10 ml) were filled with filtered 0.9% NaCl solution. Each nozzle was closed with a Luer cap, and the syringe packed in two polythene envelopes, heat-sealed and irradiated. When required, the polythene envelopes were opened with sterile scissors, and the Luer cap replaced with a cannula. Saline processed in this way had a long shelf life, was chemically insignificantly affected by radiation, and no toxic degradation products were formed. (BBB)

601 IRRADIATION-INDUCED GASES IN PACKAGED FOODS. I. IDENTIFICATION AND MEASUREMENTS. Pratt, G. B. (American Can Co., Barrington, Ill.); Kneeland, L. E.; Heiligman, F.; Killoran, J. J. J. Food Sci., 32: 200-5(Mar.-Apr. 1967).

Samples of irradiated chili, cherries, green beans, beef, and bacon in various packages, some as old as seven yr, as well as model systems, representing the major food components (water, fat, protein, and carbohydrate) were studied to determine the types and quantities of gas produced by each on exposure to sterilizing doses of irradiation. Irradiation-induced gas in various meat products exposed to 4.5 Mrad of γ irradiation at 36°F was also determined. Results showed that if foods were packaged without allowing sufficient headspace, they may show swelling after irradiation. Hydrogen gas evolution was the primary cause of the swelling. Other gases, such as CH_4, CO, and CO_2, may also be present in small amounts. In model systems, the amount of induced gas was found to vary directly with the radiation dose, and to a lesser extent with the concentration of particular food components. In a study of packaging materials, tinplate and glass had no effect on the type or quantity of gas produced. Packaging in a polyolefin plastic material caused a small increase in H_2. Product temperature during irradiation had a pronounced effect on gas production; half as much gas was produced by irradiation at temperatures below 0°C as by irradiation above this temperature. A mathematical model for estimating the production of induced gases from proximate analysis successfully predicted gas productions in the food products investigated. (BBB)

METALS, CERAMICS, AND OTHER MATERIALS

Metals and Alloys

Refer also to abstracts 203, 268, 281, 1314, 1914, and 1915.

602 (BMI-1809) PROGRESS RELATING TO CIVILIAN APPLICATIONS DURING JULY 1966–JUNE 1967. Annual Report. Keller, Donald L. (Battelle Memorial Inst., Columbus, Ohio). July 1, 1967. Contract W-7405-eng-92. 206p. Dep. CFSTI.

Separate abstracts were prepared for the 5 sections of this report on reactor fuel development for industrial application. (F.S.)

For abstracts of individual sections see: 711, 720, 724, 725, and 766.

603 (BNWL-SA-1388) FFTF FUEL SUPPLIERS' MEETING, RICHLAND, WASHINGTON, AUGUST 29–30, 1967. Burgess, C. A.; Hayward, B. R.; Roake, W. E. (comps. and eds.) (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Contract AT(45-1)-1830. 218p. (CONF-670823). Dep. CFSTI.

Separate abstracts were prepared for 14 papers presented at the meeting. The Fast Test Reactor fuel fabrication program consisting of the development, prequalification, qualification, and core procurement phases is described. Three appendixes covering cost and pricing data, buyer furnished material, and purchase order supplements are included. (J.C.W.)

For abstracts of individual papers see: 5, 280, 726, 727, 748, and 1846–1854.

604 (CONF-661011) PROCEEDINGS OF AEC-CONTRACTOR NUCLEAR MATERIALS MANAGEMENT MEETING AT LAWRENCE RADIATION LABORATORY, BERKELEY, CALIFORNIA. OCTOBER 3–5, 1966. (San Francisco Operations Office (AEC), Calif. California Univ., Livermore. Lawrence Radiation Lab.). July 1967. Contract W-7405-eng-48. 216p. Dep. CFSTI.

Seventeen papers were presented at the conference. Separate abstracts were prepared for twelve papers. Five papers appeared previously in NSA. For abstracts of these see CONF-661011 in the Report Number Index. (J.C.W.)

For abstracts of individual papers see: 6, 203, 281, 282, 605–611, and 1841.

605 (CONF-661011, pp 1-7) PROGRESS REPORT ON NUCLEAR MATERIALS MANAGEMENT. George, Douglas E. (Division of Nuclear Materials Management (AEC), Washington, D. C.).

A review of the safeguarding system for special nuclear material is given for the U. S. Atomic Energy Commission. With the interest in non-proliferation, private ownership, and industrial utilization the necessity for developing a more comprehensive and effective system for control of nuclear materials is described. (J.C.W.)

606 (CONF-661011, pp 8-10) CHANGING PATTERNS IN THE USE OF NUCLEAR MATERIAL. Kuhn, Donald W. (Division of Operations Analysis and Forecasting (AEC), Washington, D. C.).

The peaceful uses of nuclear materials are discussed. Projections for reactor power production in the United States are discussed. Potential uses of special nuclear materials in reactors for producing process heat, desalting water, nuclear rockets, SNAP reactors, and nuclear explosives for peaceful uses are described. Applications of radioisotopes are also discussed. (J.C.W.)

607 (CONF-661011, pp 29-38) AUDITING AND ACCOUNTING [OF SS MATERIALS]. Panel Discussion.

A discussion of procedures for auditing and accounting of SS materials is recorded. Auditing of mixed facilities, resident auditing as it pertains to nuclear materials management, and the AEC's audit procedures for fuel fabricators are described. (J.C.W.)

608 (CONF-661011, pp 74-9) PLUTONIUM MATERIALS: THEIR HANDLING IN RESEARCH AND DEVELOPMENT AND PROTOTYPE FABRICATION OPERATIONS. Pardue, William M. (Battelle Memorial Inst., Columbus, Ohio).

The management of plutonium materials in research and development operations at Battelle Memorial Institute is described. Rigid accountability is possible due to the radiological nature of Pu. The need for control of Pu materials arises from the financial value of the materials, diversion to military uses, and safe handling. A description is given of the processing of Pu at Battelle from the time of arrival to the disposition as scrap. (J.C.W.)

609 (CONF-661011, pp 92-103) URANIUM DETERMINATION THROUGH GAMMA COUNTING OF PRODUCTION SCRAP MATERIAL AT GENERAL ATOMIC. Wayles, W. (General Dynamics Corp., San Diego, Calif. General Atomic Div.).

The scope of scrap evaluation at General Atomic is discussed including types of material and equipment. The preparation and use of standards for calibration is mentioned in gamma counting various configurations such as plane arrays, vials and barrels. Different problem areas such as drift and high background are considered. (auth)

610 (CONF-661011, pp 146-59) OPTIMUM UTILIZATION OF SS MATERIALS. Panel Discussion. (Dow Chemical Co., [Golden, Colo. Rocky Flats Div.]).

The control procedures for optimum use of SS materials during fabrication are discussed. The problems of converting Pu residues into useable states are presented. The problems and the corresponding solutions for the optimum use of SS material in a mixed facility are listed. (J.C.W.)

611 (CONF-661011, pp 200-12) REVIEW OF CONTRACTING EXPERIENCE IN IMPLEMENTING THE SUPPLY AGREEMENT FOR FURNISHING SPECIAL NUCLEAR MATERIAL. Panel Discussion.

Prior to 1954, there was only government-owned contractor-operated plants. A review is given of the contracting procedures for furnishing special nuclear materials since 1955. (J.C.W.)

612 (GEMP-69) AEC FUELS AND MATERIALS DEVELOPMENT PROGRAM PROGRESS REPORT NO. 69. (General Electric Co., Cincinnati, Ohio. Nuclear Materials and Propulsion Operation). Sept. 29, 1967. Contract AT(40-1)-2847. 163p. Dep. CFSTI.

Developments are reported on high-temperature reactor materials, radiation effects on reactor cladding and structural materials, high-temperature thermocouple and electrical materials, refractory metal alloys, plastic fatigue properties of heat-resistant alloys, long-life reactor fuel cladding and structural materials, pressure vessel materials, meltdown of clad UO_2, properties of Fe–Cr–Al clad fuel elements and metallurgy of refractory-metal alloys. (J.R.D.)

613 REACTOR MATERIALS. Volume 10, Number 3. Simon, E. M.; Porembka, S. W. Jr.; Keller, D. L. (eds.). A Quarterly Technical Progress Review published for the Division of Technical Information, USAEC. Columbus, Ohio, Battelle Memorial Inst., Fall 1967. 69p. GPO $0.70 Domestic, $0.90 Foreign.

Progress on materials development is summarized in four sections. Separate abstracts were prepared for each section. (J.R.D.)

For abstracts of individual sections see: 217, 614, 734, and 773.

614 MODERATOR MATERIALS. Reactor Mater., 10: 152-7(Fall 1967).

A summary of reactor moderator materials includes graphite, beryllium and beryllium alloys, beryllium oxides, and solid hydrides. A listing of 21 references is given. (J.C.W.)

615 SULFUR DIFFUSION AND DISTRIBUTION IN ZIRCONIUM. Vandyshev, B. A.; Panov, A. S.; Gruzin, P. L. Fiz. Metal. Metalloved., 23: 908-12(May 1967). (In Russian).

Sulfur diffusion into zirconium in the temperature range from 870 to 1250°C was studied by a radiometric method using ^{35}S isotopes. The equations of the sulfur diffusion coefficients in α- and β-Zr as a function of temperature were obtained. The influence of polymorphic transformation on the sulfur diffusion into α–Zr was investigated. It was found that sulfur diffusion coefficients with polymorphic transformation in α–Zr exceed the coefficients without polymorphic transformation by a factor of 1.5 to 2. Autoradiographic studies were made of the distribution of sulfur in zirconium following diffusion annealing. (tr-auth)

616 THE PROPERTIES OF LIQUID METALS. Proceedings of an International Conference held at Brookhaven National Lab., Upton, N. Y., 19-23 September 1966. Adams, P. D.; Davies, H. A.; Epstein, S. G. (eds.). London, Taylor and Francis, Ltd., 1967. 748p. $22.00.

The main emphasis at the conference was on structures and electronic properties of liquid metals. Information is also in-

cluded on thermodynamic properties and mass transport. The papers are categorized in sections on structure and scattering in liquid metals, electron states in liquid metals and alloys, thermodynamic properties of liquid metals and alloys, electron transport properties of pure liquid metals and alloys, and relations between metal theory and liquid state theory. (J.R.D.)

Corrosion and Erosion

Refer also to abstract 647.

617 (EURAEC–1894) INFLUENCE OF SURFACE TREATMENT ON THE CORROSION OF TWO ZIRCONIUM ALLOYS IN HIGH-TEMPERATURE PRESSURIZED WATER AND SUPERHEATED STEAM. Special Report No. 7. Warzee, M.; Sonnen, C.; Berge, Ph. (Societe d'Etudes, de Recherches et d'Applications pour l'Industrie, Brussels (Belgium)). July 6, 1967. Contract 087-1-TEEB(RD). 26p. (EUR–3386). Dep. CFSTI.

Work performed under United States–Euratom Joint Research and Development Program.

The effects of surface treatment on the corrosion of zirconium alloys in high temperature water and steam were examined at 300 to 450°C, over relatively long periods of time. It is concluded that, under such conditions, the effects of surface treatment on the behavior of Zircaloy 2 are secondary. In the case of Zirconium – 2 Chromium – 0.16 Iron alloys in superheated steam at 450°C and 70 kg/cm^2, it seems advantageous to prepare the surfaces by electropolishing. Such treatment reduces the corrosion rate in the post-transition zone; it has no effect on the quantity of hydrogen picked up, however. Deep surface work-hardening was found to be most unfavorable in this respect. (auth)

618 (EURAEC–1895) CORROSION OF STAINLESS STEEL AND HIGH NICKEL CONTENT ALLOYS IN HIGH-TEMPERATURE SUPERHEATED STEAM. Special Report No. 8. Warzee, M.; Sonnen, C.; Cremer, J.; Berge, Ph. (Societe d'Etudes, de Recherches et d'Applications pour l'Industrie, Brussels (Belgium)). July 6, 1967. Contract 087-1-TEEB(RD). 74p. (EUR–3387). Dep. CFSTI.

Work performed under United States–Euratom Joint Research and Development Program.

A series of Fe–Ni–Cr alloys have been subjected to static corrosion tests in steam, at 500 to 700°C and 70 kg/cm^2. When the surface structure of these alloys is normally crystallized, corrosion is generally inversely related to the Ni content of the alloy. It was found that a special grade of austenitic steel, containing 0.2% C, 1.5% Si and 4% W, is much less affected by corrosion in steam at 600 or 700°C than the conventional 18/10 grades. The behavior of these alloys in superheated steam, depends more on the absence of local corrosion at grain boundaries and on the homogeneity of the alloy subjacent to the oxide layer. Heterogeneities at the grain boundaries, that seem of little importance when the corrosion process goes on in the absence of mechanical stresses, develop into a deep intergranular attack when the corrosion process occurs together with stresses such as those due to the steam pressure exerted inside tubular samples. Microscopic examination of various oxidized steel grades suggests that a high carbon content and the absence of stabilizing elements in the alloy might be favorable. When these alloys are surface cold-worked prior to being subjected to superheated steam, intergranular attack phenomena are avoided, and influence of the composition of the alloy on the corrosion level is no longer noted, the corrosion level being very low. External selective oxidation of Cr and possibly of Mn ensures the protection of all these alloys. By extending the test duration to about one year, it has been established that a cold-worked depth of several tens of microns must be attained by the machining process chosen, otherwise the oxidation behavior of the cold-worked alloys lessens after a varying period of time. Absence of recrystallization of the cold-worked areas imposes a limiting value to the temperature for each kind of alloy. The presence of oxygen in the steam (20 ppm) does not modify the behavior of the cold-worked alloys. Thermal treatments under an extremely low oxidizing atmosphere (e.g. $PH_2O/PH_2 = 10^{-5}$) may have a protective action for Fe–Ni–Cr recrystallized alloys. External selective oxidation of chromium diffusing through the grain boundaries explains this protection which, in order to be complete, requires a maximum grain size of several microns. (auth)

619 (EURAEC–1896) CORROSION OF CARBON STEELS AND STAINLESS STEELS IN PRESSURIZED WATER AT HIGH TEMPERATURES. Special Report No. 9. Warzee, M.; Sonnen, C.; Berge, Ph. (Societe d'Etudes, de Recherches et d'Applications pour l'Industrie, Brussels (Belgium)). July 6, 1967. Contract 087-1-TEEB(RD). 40p. (EUR–3388). Dep. CFSTI.

Work performed under United States–Euratom Joint Research and Development Program.

A carbon steel grade and two stainless steel grades, AISI 410 and AISI 304, have been submitted to static and dynamic corrosion tests in pressurized water at 200 to 350°C. The effects of renewal and circulation of water, surface state of the metal, pH, and oxygen content of the solution were also examined. The oxidation mechanism of steels in high temperature pressurized water has been investigated. It may be observed that the oxides formed in this medium, either on Cr or Cr–Ni alloyed steels or on unalloyed steels, appear to be formed of a double layer; the outer layer may in some cases be composed of scattered crystals. These crystals are magnetite, whatever the steel grade, and develop from ferrous hydroxide in solution. The protective character of this external layer plays an important part in the corrosion kinetics of steels in water. The most severe corrosion cases have been observed under dynamic conditions, in constantly purified water at pH 7. Under these conditions, solubility of ferrous hydroxide is very high at the test temperatures, and its accumulation is prevented, by constant purification and by high flow rates, so that a deposit of magnetite on the surfaces submitted to corrosion is impossible. The increase of the pH up to 10, diminishing considerably the solubility of ferrous hydroxide, is favorable to deposition. The direct effects of temperature on the transformation of ferrous hydroxide into magnetite partially explains the fouling of fuel elements in PWR reactors. (auth)

620 (KAPL-M–6580) STRESS CORROSION AND HYDROGEN EMBRITTLEMENT PROPERTIES OF 17-4 PH IN 600°F WATERS. Suss, Henry (Knolls Atomic Power Lab., Schenectady, N. Y.). Apr. 1967. Contract W-31-109-eng-52. 64p. Dep. CFSTI.

Stressed 17-4 PH specimens were exposed for 700 days to 600°F hydrogen-ammoniated water and to (cyclic) hydrogen-ammoniated and aerated water. The susceptibility of the alloy aged at 900°F to stress corrosion in 600°F aerated water was confirmed. No such susceptibility was evident in the hydrogen-ammoniated water. The susceptibility of the 900°F aged material to hydrogen embrittlement in both water conditions was shown. This susceptibility was evident only with a high applied stress of 165,000 psi for air melt and 100,000 psi for consumable electrode melt materials. No stress corrosion attack of the alloy aged at 1025°F or 1100°F in either environment was indicated. The one failure of each 1025°F aged and 1100°F aged, with applied stresses close to yield strength, has been attributed tentatively to hydrogen embrittlement. The consumable electrode heats appeared more susceptible to hydrogen embrittlement than air melt material. The alloy in the three aged conditions (900°F, 1025°F and 1100°F) was subject to secondary aging resulting in increase in hardness up to 4 R_c units and 20,000 psi in tensile strength – with some loss in ductility. Additional studies are recommended to establish the significance of the secondary aging on the mechanical, impact, stress corrosion, and hydrogen embrittlement properties of 17-4 alloy aged at 1025 and 1100°F. (auth)

621 GAS PHASE ANODIZATION OF TANTALUM. Jennings, T. A. (Frankford Arsenal, Philadelphia); McNeill, W.; Salomon, R. E. J. Electrochem. Soc., 114: 1134-7(Nov. 1967).

The anodic oxidation of tantalum in the gas phase was studied using an electromagnetic ion cathode. The anodic films were prepared at constant current densities of 1.0 and 2.0 ma/cm^2. The growth characteristics of anodic tantalum oxide films, in the gas phase, were found to be similar to films prepared in liquid electrolytes. A comparison was made between the results of this study and other reported gas-phase reactions with various anode surfaces. The tantalum oxide growth, for experimental conditions reported, is shown to be linearly dependent on the total charge passed in the anode circuit during the reaction up to a formation voltage of 200V. (auth)

622 LOW-PRESSURE OXIDATION OF ZIRCONIUM. Levitan, J.; Draley, J. E.; Van Drunen, C. J. (Argonne National Lab., Ill.). J. Electrochem. Soc., 114: 1086-9(Nov. 1967).

Low-pressure oxidation of zirconium at high temperatures exhibited a pressure dependence, and several stages of oxidation could be distinguished: an initial period was followed by two periods with a linear rate dependence. Transition from the first linear period to the following linear period was accompanied by an increase in oxidation rate. Surface reaction control is suggested for these periods. Linear oxidation was followed by a period when the rate was limited by a protective oxide film. (auth)

623 THE OXIDATION PROPERTIES OF A ZIRCONIUM-2.7 w/o NIOBIUM ALLOY IN THE TEMPERATURE RANGE 300

TO 500°C. Cowgill, M. G.; Smeltzer, W. W. (McMaster Univ., Hamilton, Ont.). J. Electrochem. Soc., 114: 1089-95(Nov. 1967).

The reaction kinetics and structures of the alloy/oxide composite system were determined for martensitic and several Widmanstatten-structured alloys oxidized at 300, 400, and 500°C in oxygen at 1 atm pressure. At 300 and 400°C, there was little difference between the oxidation rates of the differently structured alloys in the early stages of the reaction. Prolonged exposures illustrated the occurrence of two limiting oxidation curves. Martensitic specimens oxidized most rapidly and the oxidation rate decreased until a transition range was attained in which the rate subsequently increased to a maximum value associated with linear kinetics. Widmanstatten-structured specimens containing equilibrium amounts of proeutectoid alpha-zirconium from the quench temperature oxidized most slowly, the initial decreasing oxidation rates finally approximating linear kinetics at long exposures. Specimens containing intermediate amounts of proeutectoid alpha-zirconium oxidized at rates between these two limiting cases. At 500°C, the initial oxidation rates for all alloys approximated parabolic kinetics and the reaction rate constants were directly dependent on the volume fractions of martensite. The oxide was cracked in the range of linear kinetics, but the role of the film as a barrier to oxidation could not be determined. The formation of oxide pustules on martensitic specimens was the only distinct feature indicating a difference in the mode of oxide formation on differently structured alloys. The major product of the reaction at all temperatures irrespective of alloy structure was an oxide whose structure could be indexed as monoclinic zirconia. (auth)

624 BERYLLIUM FLUORIDE COATING AS A CORROSION RETARDANT FOR BERYLLIUM. O'Donnell, P. M. (Lewis Research Center, Cleveland). Corros. Sci., 7: 717-18(Oct. 1967).

It has been shown that a high temperature modification of BeF_2 is formed when Be is reacted with F_2 above 525°C, identified as rhombic tridymite type. It has a glassy appearance and is insoluble in water. A film of this material was found to protect Be against aqueous corrosion. Corrosion tests are briefly described, using Be strips treated with F_2 at 625°C and 200 torr to form 2000 Å and 12,000 Å fluoride films. The progress of corrosion was followed by recording weight gains with time. Samples remained essentially unchanged in distilled water for about 3,000 hr, and showed less film build-up in tap water compared with unfluorinated controls. Some studies were also made in water with high Cl^- concentration. In this case the net weight change was negative. Weight gain due to corrosion film formation was not as prominent as weight loss due to crack formation, embrittlement, and loss of metal. A fluoride coating of 2000 Å was sufficient to retard corrosion; the thicker coatings of 12,000 Å gave poor corrosion resistance in dynamic tests, probably due to nonadherence under high flow conditions. (UK)

625 HIGH-TEMPERATURE OXIDATION MECHANISM IN 2.5 PERCENT TIN–ZIRCONIUM ALLOY. Maekawa, Tatsuo; Ishii, Bunpei. Trans. Jap. Inst. Metals, 7: 123-8(Apr. 1966).

The breakaway oxidation, mainly at 850°C, of 2.5% Sn–Zr alloy in oxygen was investigated by thermogravimetric measurement, electron microscopy, electron-probe microanalysis, and x-ray diffraction analysis. In the postbreakaway stage, the oxidation kinetics was remarkably affected by the pressure of oxygen, and severe cracking of the oxide film was observed. The electron-probe microanalysis and x-ray diffraction analysis indicated that the Sn in the alloy was precipitated as an intermetallic compound of ZrSn at the oxide/metal interface, and suggested that the oxide film has a multilayer structure consisting of ZrO_2 and $(ZrSn)O_2$ layers. The mechanism of the pronounced breakaway phenomenon of Sn–Zr alloy is discussed on the basis of the behavior of Sn in the alloy. It was concluded that stress between the layers of ZrO_2 and $(ZrSn)O_2$ induced the cracking of the oxide film and permitted the increased oxidation. (Rev. Met. Lit.)

626 INFLUENCE OF ALLOYING IMPURITIES ON THE CORROSION RESISTANCE OF STEELS IN WATER AND STEAM AT ELEVATED TEMPERATURES AND PRESSURES. Gromova, A. I.; Gerasimov, V. V.; Chernyakova, T. Ya. Zashch. Metal., 3: 625-7(Sept.-Oct. 1967). (In Russian).

The corrosion rate of steels with small additions of Mo, Ni, W, Al, and Si was studied in water and in superheated steam at 300 and 500°C and 87 kg/cm² and 100 kg/cm² pressures, respectively. (R.V.J.)

Preparation and Fabrication

627 (AI-CE-72) HEAVY WATER ORGANIC COOLED REACTOR. DEVELOPMENT OF A STAINLESS STEEL–ALUMINUM TRANSITION JOINT FOR HIGH-TEMPERATURE SERVICE. Jackson, W. R. (Atomics International, Canoga Park, Calif. Combustion Engineering, Inc., Windsor, Conn. [Nuclear Div.]). Sept. 25, 1967. Contract AT(38-1)-430. 32p. Dep. CFSTI.

A stainless steel–aluminum transition joint for use at elevated temperatures has been developed. The joint consists of a stainless steel tubular section metallurgically bonded to an aluminum sleeve by hot isostatic pressure bonding. A tungsten barrier layer is incorporated to prevent diffusion between the stainless steel and aluminum components. The transition joint was developed to provide a means to penetrate the aluminum alloy end plugs of SAP-clad, UC fuel rod assemblies with instrument leads. These fuel rod assemblies were fabricated in support of the Heavy Water Organic Cooled Reactor (HWOCR) Program. Transition joints have been fabricated and have allowed fuel centerline temperatures and fission gas release data to be obtained from HWOCR irradiation experiments for in-pile operating periods >10,000 hr. More than two hundred transition joints have been fabricated and utilized in determining the long-term, stress-rupture properties of irradiated and unirradiated SAP cladding. They have operated successfully in out-of-pile stress rupture tests for up to 8000 hr at 750 to 900°F and differential pressure loadings of 400 to 700 psig. (auth)

628 (N-67-18942) COLD MOLECULAR WELDING STUDY. Quarterly Report, September 15–December 15, 1966. Hopkins, Vern (Midwest Research Inst., Kansas City, Mo.). Jan. 23, 1967. Contract NAS9-3623. 6p. (NASA-CR-65593). CFSTI.

Beryllium–copper pellets were cold welded on 321 stainless steel wear plates in studies to obtain a better understanding of cold welding evaluation techniques. Results are presented in tabular form for three investigations: (1) the reproducibility of test results under identical experimental conditions, (2) a comparison between sliding tests in ultra-high vacuum, dry air, and ambient air, and (3) the effect of alternate sliding and resting of metal couples for two sliding durations between stops. A brief interpretation of the results based on visual observations is also included. (STAR)

629 (N-67-19274) STUDY OF DISSIMILAR METAL JOINING BY SOLID STATE WELDING. Final Report. Crane, C. H.; Torgerson, R. T.; Lovell, D. T.; Baginski, W. A. (Boeing Co., Seattle, Wash. Aerospace Group). Oct. 1, 1966. Contract NAS8-20156. 199p. (NASA-CR-82460). CFSTI.

Investigations were conducted to study the solid state welding of six dissimilar alloy combinations by press and roll diffusion welding and to establish the influence of major processing variables upon diffusion phenomena, and determine the characteristics of diffusion welded joints between six dissimilar metal combinations. The influence of the primary diffusion parameters (time, temperature, and pressure) and of the process variables (surface preparation, atmosphere, and diffusion aid materials) was studied on the following six diffusion couples: (1) 2219 aluminum alloy to 321 stainless steel, (2) 7106 aluminum alloy to 321 stainless steel, (3) 2219 aluminum alloy to Ti–5Al–2.5 Sn titanium alloy, (4) 321 stainless steel to Ti–8Al–1Mo–1V titanium alloy, (5) 321 stainless steel to Inconel 718 alloy, and (6) Inconel 600 to Ti–8Al–1Mo–1V titanium alloy. Metallurgical analyses were performed to follow element migration, to identify the compositions of the diffusion zones, and to determine the influence of thickness and hardness of the diffusion zones on the properties of the joint. Additional studies were made on the effect of material condition (heat treatment and strain hardening) on diffusion welding. The most promising diffusion welding techniques were further identified by metallurgical evaluation, mechanical and thermal shock testing, leak testing, and by corrosion studies. The joining techniques which were determined to be the most promising were further analyzed by a theoretical projection of the diffusion welding process for production applications. (auth) (STAR)

630 (N-67-22856) ALUMINUM-TO-COPPER COLD-WELDED JOINTS FOR SNAP-8 ELECTRICAL TERMINAL APPLICATIONS. Bleil, H. E. (Aerojet-General Corp., Azusa, Calif.). July 16, 1965. 7p. (NASA-CR-72194; TM-4923-65-4-309). CFSTI.

Joints of ETP Cu coldwelded to 6061-T6 Al were evaluated by mechanical testing and metallographic examination after thermal exposure at 350°F for times up to 3000 hours. It was concluded that the joint is adequate for the intended use as SNAP-8 electrical terminal transition pieces where they will be exposed to a maximum temperature of 350°F for 10,000 hours. (auth)

631 (N-67-22891) PRELIMINARY EXAMINATION OF PROTOTYPE REFRACTORY BIMETALLIC TUBING FROM NUCLEAR METALS, INCORPORATED. Landusky, C. A. (Aerojet-General Corp., Azusa, Calif.). Jan. 27, 1964. 11p. (NASA-CR-72202; TM-390-64-4-199). CFSTI.

Prototype tubing of Nb/316SS and Nb–1Zr/316SS were evaluated to determine the bond quality. The tests employed were metallographic and ultrasonic inspection before and after coiling to an eight-inch diameter. This tubing was produced by hot co-extrusion and cold reduction. The bond in the Nb/316SS tubing was perfect on the basis of the tests applied. The Nb–1Zr/316SS tubing had extensive unbounded areas in the as-received condition. After coiling, the entire outside diameter of this coil was unbonded. (auth)

632 (ORNL–4108) INITIAL DEVELOPMENT OF HFIR FUEL ASSEMBLIES. Beaver, R. J.; Tackett, J. W.; Erwin, J. H.; Slaughter, G. M.; Kucera, W. J. (Oak Ridge National Lab., Tenn.). Oct. 1967. Contract W-7405-eng-26. 66p. Dep. CFSTI.

Development of HFIR-type fuel assemblies aimed at demonstrating feasibility and concluded with the fabrication of the 8-kg-^{235}U aluminum-base fuel assembly for the HFIR Critical Experiment No. 2 is described. The fuel loading for this critical test was low enough that the alloy Al–24% U could be used as the fuel material for the outer-annulus plates. Boron was specified as a burnable poison addition to the inner-annulus plates only. Powder metallurgy was selected as the process for making a fuel mixture containing 26 wt % U_3O_8, 0.07 wt % B_4C, balance aluminum. These cores were first cold pressed to rectangular blocks and later hot pressed to the specified contour. Aluminum pieces were made to match the contours of both types of fuel cores. Alclad plates containing these contoured core pieces were made by hot rolling, and the plates were shaped into involutes. The plates were assembled into fuel arrays and joined by mechanical fastening and welding. The results of this program showed that processing HFIR fuel plates and elements with precise control of dimensions and fuel loading is feasible. Blistering of fuel plates was the major problem encountered. (J.R.D.)

633 WELDING IN THE CONSTRUCTION OF PRESSURE VESSELS FOR REACTORS. PART 1. VESSELS FOR INDUSTRIAL NUCLEAR REACTORS. Juffy, E. A. Przegl. Spawalnictwa, 17: 10-16(1965). (In Polish).

World experience in the construction of pressure vessels for nuclear reactors is considered. The characteristics of gas-cooled reactor pressure vessels are given with constructional diagrams of cylindrical and spherical boilers and their main piping and support systems. Particulars are noted of cylindrical water boilers in reactors with excess pressure. Whatever their type, all reactor boilers are made of mild steel, or of mild steel with molybdenum added. Certain details are given of the technology for constructing type BRW reactor boilers and type PWR water reactor boilers. (Rev. Met. Lit.)

634 WELDING IN THE CONSTRUCTION OF HIGH-PRESSURE VESSELS FOR REACTORS. PART 2. STEELS FOR REACTOR BOILERS. Juffy, E. Przegl. Spawalnictwa, 17: 190-3 (1965). (In Polish).

The physical and mechanical properties are given for weld metal in different types of steel, with relation to the type of reactor concerned. (Rev. Met. Lit.)

635 THE GROWTH OF SINGLE CRYSTALS OF Nb_3Sn BY CHEMICAL TRANSPORT. Hanak, J. J.; Berman, H. S. (RCA Labs., Princeton, N. J.). J. Phys. Chem. Solids, 28: Suppl. 1, 249-53(1967).

Single crystals of the superconducting compound Nb_3Sn weighing up to 1 g were grown by means of chemical transport using HCl as transporting gas in molybdenum ampules. The transport proceeded from lower to higher temperatures, which were approximately 850 and 900°C, respectively. Single crystalline growth occurred at rates of about 18 Å/sec, whereas strictly polycrystalline growth took place at a rate of 144 Å/sec. The dislocation density of these crystals typically ranged between 10^3 and 10^5 per cm^2, and the total level of impurity was as low as 50 ppM. Crystals rich in tin by as much as 1.2 wt. % and with a lattice constant as high as 5.298 Å were obtained. Superconducting transition temperatures ranged between 17.8 and 18.2°K. (UK) (auth)

636 THE EFFECT OF Cr AND Mo ON ISOTHERMAL FORMATION OF PEARLITE. Nicodemi, W.; Ravizza, P. (Nazionale Cogne, Aoste, Italy). Rev. Met. (Paris), 64: 483-91(May 1967). (In French).

The effects of Cr and Mo at concentrations of 1.00 to 3.00% Cr and 0.00 to 0.75% Mo on the rates of nucleation and growth of pearlite nodules were determined. The experimental procedure is described in detail. From a statistical study of the results, rules defining the effects of these elements separately and in combination on the formation and growth of pearlite were derived. (J.S.R.)

637 SOME PROBLEMS IN THE MELTING AND CASTING OF URANIUM AND ITS ALLOYS. Hueston, F. H.; Barclay, R. S. (Eldorado Mining and Refining Ltd., Port Hope, Ont.). Can. Mining Met. Bull., 60: 795-8(July 1967).

Depending on the application, zirconia, fused magnesia, and graphite were found to be the most suitable crucible materials for melting uranium metal and its alloys. Although graphite was found to be satisfactory for uranium and uranium alloy castings with cross sections of 4 square inches or greater, ceramic-type molds are superior for small sections and those shaped castings which prohibit the economic use of machined graphite molds. Heating cycles, addition mechanisms, and furnace conditions for melting are discussed. (auth) (UK)

638 METHOD OF PRODUCING SHAPED PRODUCTS OF SINTERED POWDERS. Lirones, Nick George (to Howe Sound Co.). British Patent 1,088,560. Oct. 25, 1967. Filed Oct. 16, 1964.

A method for producing shaped products of sintered powders is described. The powders, including metals, alloys of metals, ceramics, alone or with a binder, are formed into composites of high strength. The high melting powder is put in a mold having an enclosed cavity in which at least the inner portions of the mold wall are formed of graphite flour and colloidal graphite alternating with layers of graphite stucco and the rest formed of graphite materials or inorganic-ceramic materials. Powders used include Be, Cr, Nb, Mo, Ta, Ti, W, and Zr, their oxides and metallides. The sintering temperature is 2100°F. (F.S.)

639 IMPROVEMENTS IN OR RELATING TO THE SINTERING OF BERYLLIUM. Butcher, John William; Samuel, Robert Lionel (to United Kingdom Atomic Energy Authority). British Patent 1,088,049. Oct. 18, 1967. Filed Oct. 7, 1963.

A process for hot pressing Be powder particles derived from cast Be into high density compacts is described. The Be particles have an inert nonmetallic surface layer which forms a barrier to the formation of Be–Be metal bonds between the particles. A valence imbalance in the surface layer is produced by adding a sufficient amount of Si to promote Be diffusion through the layer but not enough to form a compound or eutectic phase with Be. Hot pressing is accomplished in a vacuum for sintering. The sintered compacts have high density and strength, display no isolated grain growth, and little anisotropy in physical properties. (F.S.)

640 GAS PRESSURE BONDING. Hodge, Edwin S.; Peterson, J. H.; Tassin, M. S. Jr. (to U. S. Atomic Energy Commission). U. S. Patent 3,340,053. Sept. 5, 1967.

A method of making tungsten metal shapes from tungsten powder comprises packing the powder into a sealed container and isostatically pressing the container at a temperature and pressure high enough to sinter the tungsten particles. The sealed container consists of a gas-impervious casing made from titanium, tantalum or niobium and a gas-pervious inner liner made from molybdenum or tungsten. (auth)

641 NUCLEAR GRADE, URANIUM METAL MELT STOCK, NUCLEAR GRADE, URANIUM DIOXIDE, SINTERABLE. NUCLEAR GRADE, URANIUM DIOXIDE, COMPACTIBLE. American Standards Association N5.4,5,6(1965). New York, American Institute of Chemical Engineers, 1965. 44p.

Specifications and standards developed by Sectional Committee N5 of the American Standards Association for nuclear grade U melt stock, sinterable nuclear grade UO_2, and compactible grade UO_2 are presented. Particular items detailed are lot-size, sampling, physical and chemical properties. For the sintering grade UO_2 precise directions are given for conducting the sintering tests. A guide to provisions for purchasing, accounting for, and shipping nuclear materials and a glossary of terms relating to nuclear fuels is included. (P.G.C.)

642 FORGEABLE CORROSION-RESISTING STEEL WITH HIGH NEUTRON-ABSORPTION CAPACITY. Persson, K. G. S.; Lindroth, Ph.; Hellner, L. I. (to Aktiebolaget Fofors). Canadian Patent 760,929. June 13, 1967. Priority date Dec. 8, 1962, Sweden.

An alloy steel is described which contains a maximum of 0.15% C, 15-30% Cr and a maximum of 5% B. It has good hot-working properties and may be forged at 950 to 1100°C from ingots into bars for use as reactor control rods. Boron is added as titanium boride. (F.S.A.)

Properties Evaluations

Refer also to abstracts 235 and 270.

643 (AD-645143) PROPERTY CHARACTERIZATION OF A DUCTILE, TUNGSTEN-BASE SHEET ALLOY. Final Report,

February 8–November 1, 1966. Maykuth, D. J.; Grube, K. R.; Hauser, D.; Bartlett, E. S. (Battelle Memorial Inst., Columbus, Ohio). Nov. 7, 1966. Contract NOw-66-0319. 39p. CFSTI.

A supply of W-5Re-2.2ThO2 (wt %) alloy sheet was prepared using procedures developed under a previous contract. This material was evaluated for recrystallization behavior, bend-transition temperature, tensile and stress rupture strengths at temperatures to 1928°C as well as for weldability by electron-beam and gas-tungsten-arc welding. (auth)

644 (AD–647889) THE EFFECT OF NITROGEN ON THE TENSILE AND CREEP-RUPTURE PROPERTIES OF NIOBIUM. Interim Report. Stoop, J.; Shaninian, P. (Naval Research Lab., Washington, D. C.). Oct. 31, 1966. 24p. (NRL–6464). CFSTI.

Variations in the mechanical properties of Nb caused by N additions in amounts to give single-phase and two-phase structures were investigated at both room and high temperatures. Nitrogen in solid solution raised room-temperature hardness and tensile strength. Increasing the N content to give two-phase structures however produced no additional strengthening. At elevated temperatures, the effect was different in that, with increase in N content, there was a continued rise in tensile strength through the two-phase region. Creep-rupture strength of N was improved by N in solution at temperatures slightly below 0.5 times the melting temperature, whereas above this temperature the strength was unaffected. This change in the N effect with temperature appears to be related to a concurrent change in the mechanism controlling creep. An increase in the N content of the two-phase alloys produced strengthening throughout the 1700 to 2600°F test range. Ductility was high for all alloys at elevated temperatures and, except for a high-nitrogen alloy, also at room temperature. (auth)

645 (AECL-2768) THE COMPATIBILITY OF W-26 % Re WITH THORIA AND THORIA–PLUTONIA. Jeffs, A. T. (Atomic Energy of Canada Ltd., Chalk River (Ontario). Chalk River Nuclear Labs.). Sept. 1967. 6p. Dep. CFSTI. CAN.

The results are reported of laboratory and irradiation tests to determine the compatibility of tungsten-rhenium thermocouple alloy with thoria and thoria–plutonia under the conditions of a proposed instrumented pellet rod. The test results proved satisfactory compatibility. The absence of any evidence of interaction gives confidence in the behavior of the complete thermocouple under operating conditions. (auth)

646 (BMI–1817) INVESTIGATION OF THE INITIATION AND EXTENT OF DUCTILE PIPE RUPTURE. Quarterly Progress Report, July–September 1967. Eiber, Robert J.; Maxey, Willard A.; Duffy, Arthur R.; Atterbury, Thomas J. (Battelle Memorial Inst., Columbus, Ohio). Oct. 1, 1967. Contract W-7405-eng-92. 16p. Dep. CFSTI.

In determining the size of defects required to initiate fracture in typical PWR and BWR primary coolant piping and the extent of rupture, two tests were conducted on 24 in. OD A106B carbon steel pipe with a 1.5 in thick wall. The object of the first test was to examine the extent of fracture propagation in a test specimen containing a wet vapor of ~1.4% quality steam. The fracture propagated the length of the pipe in an unstable manner believed to be the result of the decompression characteristics of the wet vapor. The second test was to obtain information on the behavior of through-wall cracks at relatively high stress level under pressurized water conditions. The fracture extended on each end of the test specimen in a ductile mode ~8.5 in. (F.S.)

647 (BNL–50077) HIGH-TEMPERATURE LIQUID-METAL TECHNOLOGY REVIEW. A Bimonthly Technical Progress Review. Volume 5, Number 4. (Brookhaven National Lab., Upton, N. Y.). Aug. 1967. 188p. Dep. CFSTI.

Research and development programs in the field of high-temperature liquid-metal technology are reviewed. Materials development, corrosion and mass transfer, heat transfer, fluid dynamics, instrumentation, purification, component development, physical properties, thermodynamics, chemical analysis, and power systems are covered. (M.C.G.)

648 (BNWL–560) CRACK PROPAGATION CHARACTERISTICS OF Zr–2.5 WT PERCENT Nb ALLOY TUBING. Pankaskie, P. J. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Oct. 1967. Contract AT(45-1)-1830. 33p. Dep. CFSTI.

The crack propagation behavior of Zr–2.5 wt % Nb alloy tubing, as determined from tests using milled slots as stress concentrators, is not significantly altered by cold working or heat treatments from room temperature to 300°C. When hydrided to 250 to 300 ppM of hydrogen, the fracture strength of a defected tube is generally reduced and its crack propagating behavior tends to be less predictable. Fatigue testing of tubes in the tension-tension mode by cyclic internal pressurization at peak cyclic hoop stresses of about one-fifth of ultimate hoop strength was continued until fatigue crack growth and catastrophic failure occurred. It appears that under these loading conditions, leakage through a fatigue crack is likely to occur when the fatigue crack dimensions are appreciably smaller than the critical size for catastrophic failure. Data obtained suggest that the critical crack length for catastrophic failure may diminish with increasing amounts of prior fatigue damage. (auth)

649 (BNWL-SA–1134) SUBCRITICAL CRACKING OF TITANIUM ALLOYS AND HIGH-STRENGTH STEELS IN ORGANIC ENVIRONMENTS. Rowe, R. G. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). July 20, 1967. Contracts AT(45-1)-1830; AT(45-1)-1831. 12p. (CONF-670325–1). DTIE.

From Seminar on Accelerated Crack Propagation in Titanium, Columbus, Ohio.

The influence of external environment on the rate of sub-critical crack propagation in a fully hardened D2 tool steel and a Ti–6Al–6V–2Sn alloy was investigated. In tests conducted on the tool steel it was found that small amounts of H_2 in a relatively humid atmosphere and high stresses at the crack tip were necessary to cause significant increases in the cracking rate. It was determined that the stress dependence of the crack growth process was greater in the Ti alloy for all environments. Application of benzene to the crack tip caused a sharp increase in the rate of sub-critical cracking. Methods and equipment used in the tests are discussed as well as the methods and formulas used in analysis of the experimental data. Results of the tests are presented graphically. (P.G.C.)

650 (FEI–52) KRITICHESKIE PARAMETRY SHCHELOCHNYKH METALLOV. (Critical Parameters of Alkali Metals). Kirillov, P. L. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Obninsk. Fiziko-Energeticheskii Institut). 1966. 32p. (In Russian). Dep.

Knowledge of the critical parameters is necessary in generalizing data on heat transfer in a two-phase region and on critical heat fluxes of alkali metals on the basis of the theory of thermodynamic similarity, but existing methods of calculating the critical parameters involve empirical dependences based on approximate thermodynamic similarity. Those parameters can be very correctly obtained from the van der Waal constants with consideration of vapor dimerization, and with them generalized expressions can be obtained for the heat of evaporation, surface tension, and vapor pressure. (JPRS)

651 (LA–3739) FRICTION INDEX AND PRESSING CHARACTERISTICS OF SPHERICAL STAINLESS STEEL POWDER AND OXIDIZED COPPER POWDER. Sheinberg, H. (Los Alamos Scientific Lab., N. Mex.). June 14, 1967. Contract W-7405-eng-36. 9p. Dep. CFSTI.

A procedure is described for accumulating data on the friction index and compression ratio of a copper powder at different stages of oxidation and screened fractions of a stainless steel powder. The dimensionless and nameless powder property, friction index divided by the compression ratio, under certain conditions, was constant for a regular series of size fractions of stainless steel powder. Calculations were made of the coefficient of compression and the limiting value of the degree of volume change in the manner of Kawakita. (auth)

652 (N–67-22066) DEVELOPMENT AND EVALUATION OF MAGNETIC AND ELECTRICAL MATERIALS CAPABLE OF OPERATING IN THE 800 TO 1600°F TEMPERATURE RANGE. Quarterly Report, December 1, 1965–February 28, 1966. Kueser, P. E.; (and others) (Westinghouse Electric Corp., Lima, Ohio. Aerospace Electrical Div.). Mar. 1966. Contract NAS3-6465. 253p. (NASA-CR–54358; QR–5). CFSTI.

Details are presented on the continuing development of high temperature materials for eventual use in advance space electric power systems. Martensitic alloys and Co base alloys were precipitation hardened, and the alloys with the best strength and magnetic properties are identified. In the dispersion strengthening research, Fe–27% Co base materials provide better magnetic properties but have less tensile strength than the Co–B–Nb alloy. Continued creep testing is mentioned. In the high quality dielectric development, lightweight capacitors made with pyrolytic BN wafers were found to have a high RC product and good thermostability. Bore seal development and combined material investigation under space environment conditions are discussed. Bond tests on Nb–1Zr joined to Be ceramics by the active metal braze, 60Zr–25V–15Nb, showed greater flexural strengths and greater ductility than any other active metal–braze system tested. Continued investigations on the stator, transformer, and solenoid test vehicles are also reviewed. (N.E.N.)

653 (N-67-22439) THERMODYNAMIC PROPERTIES OF INTERSTITIAL ELEMENTS IN THE REFRACTORY METALS. Semiannual Report, June 1-December 1, 1966. Singh, R.; Seigle, L. (State Univ. of New York, Stony Brook, Coll. of Engineering). 24p. (NASA-CR-83391; SAR-1). CFSTI.

The thermodynamic properties of C dissolved in solid Mo, W, Nb, and Ta were estimated from the phase equilibrium diagrams of the respective metal-carbon systems, and knowledge was obtained of the free energies of formation of the di-metal carbides in equilibrium with the terminal solid solutions. Values of the partial molar heats and vibrational entropies of carbon in the terminal solid solutions are presented, and the accuracy of the calculations is discussed. (auth)

654 (N-67-22884) INVESTIGATION OF THE ADHESION OF METALS IN ULTRA-HIGH VACUUM. Hordon, M. J.; Roehring, J. R. (National Research Corp., Cambridge, Mass. Norton Exploratory Research Div.). Dec. 1966. Contract NAS1-2691. 52p. (NASA-CR-66279). CFSTI.

Adhesion-friction tests were conducted at vacuum levels below 1×10^{-9} torr for annealed Cu, Ti, and W. Prior to contact under loads up to 1000 lbs, mating cup-and-cone shaped specimens were subjected to xenon ion gas bombardment or rotational self-abrasion. Subsequently, residual shear torque, frictional torque, and normal adhesion forces were measured. (auth)

655 (N-67-22893) THE MECHANICAL PROPERTIES OF 9 PERCENT Cr, 1 PERCENT Mo (9M) STEEL ALLOY. Romero, Carlos J. (Aerojet-General Corp., Azusa, Calif.). May 27, 1963. 43p. (NASA-CR-72207; TM-390-63-4-116). CFSTI.

Ten thousand hour tensile data with complete chemistry, fabrication, and heat treatment history were accumulated, correlated, plotted, interpreted, and extrapolated to 1400°F to issue 1% creep and stress-rupture design values to be used between 1300 and 1350°F for a 9% Cr, 1% Mo (9M) alloy steel to be used in the fabrication of components for the SNAP-8 system. Equations were used to calculate curves for approximate endurance limits at various temperatures for this alloy. Preliminary correlations were established between composition elements, heat treatment, and 10,000 hour strength levels. Microphotographs and an isothermal transformation diagram are used to indicate that a finely dispersed carbide network is desired for 10,000 hour service at 1300 to 1350°F as required by the SNAP-8 system. It is concluded that a formal statistical study is desirable to establish optimum alloy composition for maximum 10,000 hour strength at temperature and that tests should be performed to obtain endurance limit values, short-time tensile stress-strain curves at temperatures of interest, and to establish potential fabrication difficulties due to alloy upgrading. (auth)

656 (NAA-SR-11959) THERMOPHYSICAL PROPERTIES OF SNAP FUEL MATERIALS. Nakata, M. M.; Ambrose, C. J.; Finch, R. A. (Atomics International, Canoga Park, Calif.). Sept. 25, 1967. Contract AT(04-3)-701. 93p. Dep. CFSTI.

Results of thermal diffusivity, heat capacity, thermal conductivity, and electrical resistivity measurements, made on SNAP fuel materials, are presented. Compositions investigated include the unhydrided zirconium-10 wt % uranium alloy and the alloy hydrided to 0.50, 1.26, 1.58, 1.81, and 1.90 H/Zr atom ratios. Anomalies observed in the property vs temperature curves are discussed and related to the available phase diagrams. (auth)

657 (NAA-SR-12446) STATIC AND SLIDING CONTACT BEHAVIOR OF MATERIALS IN SODIUM ENVIRONMENTS AT ELEVATED TEMPERATURES. Freede, W. J.; Newcomb, L.; Kennedy, R. S. (Atomics International, Canoga Park, Calif. Liquid Metal Engineering Center). Sept. 29, 1967. Contract AT(04-3)-700. 64p. Dep. CFSTI.

Tests are in progress to determine static and sliding contact behavior characteristics of selected candidate material combinations in liquid and vapor sodium environments with inert cover gas at elevated temperatures. Most static contact tests showed that self-welding of materials in sodium tended to progress with time at environment. Composition and hot hardness of specimens affected results more than did variations in sodium environment. Sliding contact tests indicated that metals should be heat-treated to their maximum practical hardness. Material combinations of hard vs hard tended to be more wear-resistant than hard vs soft. Material buildup instead of wear on sliding contact surfaces was observed in a number of tests. Substantial differences in wear behavior were observed in materials of different compositions with somewhat similar hot hardness characteristics. (auth)

658 (NYO-3814-1) BINARY MULTIPHASE DIFFUSION IN METALLIC SYSTEMS. [PART] I. Progress Report No. 1, February 1-October 31, 1967. Castleman, Louis S.; Lyttle, J.; Dembowski, P. (Polytechnic Inst. of Brooklyn, N. Y. Dept. of Physical and Engineering Metallurgy). Contract AT(30-1)-3814. 24p. Dep. CFSTI.

An investigation is underway to determine the origin, structure, and morphology of non-planar interfaces in binary multiphase diffusing systems. Effort has largely been concentrated on a study of the aluminum-antimony system. Although the investigation is not yet complete, the following conclusions appear to be warranted. It has been confirmed that the intermediate phase, AlSb, forms at the interface of aluminum-antimony diffusion couples and grows in a highly irregular fashion during isothermal diffusion at 600°C. The phenomenon does not appear to be due primarily to the scarcity of suitable sites for the nucleation of AlSb at the aluminum-antimony interface at the start of diffusion. Preferential growth of the AlSb layer along grain boundaries of aluminum and antimony owing to grain boundary diffusion does not play a significant role. Tentatively, it appears that the growth of the intermediate phase, InSb, in the indium-antimony system is similar to that of AlSb in the aluminum-antimony system. The results suggest that existing theory is inadequate to explain irregular growth of intermediate phases in binary diffusing systems and that the crystal structure of the intermediate phases may be an important factor. (auth)

659 (UCRL-17774) EFFECT OF INITIAL DISLOCATION DENSITY ON SINGLE SLIP STRAIN HARDENING OF COPPER. Washburn, Jack; Murty, Gollapudi (California Univ., Berkeley. Lawrence Radiation Lab.). Aug. 1967. Contract W-7405-eng-48. 33p. (CONF-670909-8). Dep. CFSTI.

From International Conference on the Strength of Metals and Alloys, Tokyo, Japan.

Copper crystals in which different dislocation densities were introduced by multiple slip were subsequently deformed in tension in single slip. In all cases three stages were found on the stress strain curves. Detailed observations of surface slip markings were carried out on all specimens. It was shown that Stage I in prestrained specimens was due to progressive deformation starting at points of stress concentration and propagating through the gage length. Stress strain curves and shear strain distribution were found to change in a regular way with initial dislocation density; the results from as-grown specimens are seen as part of a homologous series which includes all of the results from prestrained specimens. It is suggested that Stage I in pure copper is at least partly due to unavoidable prestrains during cooling, handling, and pre-yield loading. Linking of slip clusters to form groups that grow entirely across the specimen was found during all stages of deformation, even for as-grown crystals. Surface slip markings that were formed at a given stress level, whether in Stage I of a prestrained crystal or in Stages II or III of an as-grown crystal, were found to be similar. It was suggested that the type of instability of the dislocation substructure that is responsible for clustering of slip into definite bands and the existence of Stage I in prestrained specimens also develops gradually in a specimen deformed from the start in single slip and that the decrease in hardening rate in Stage III is associated with the instability of dense three-dimensional dislocation tangles within which the net Burgers vector is nearly zero. (auth)

660 (UCRL-17805) STRENGTH AND DUCTILITY OF METASTABLE AUSTENITIC STEELS AS A FUNCTION OF COMPOSITION AND TEST TEMPERATURES. Chanani, Govind Ram (California Univ., Berkeley. Lawrence Radiation Lab.). Sept. 1967. Contract W-7405-eng-48. 74p. Dep. CFSTI.

Thesis.

The combined and individual effects of composition, test temperature, and temperature of deformation on the tensile properties and strain-hardening characteristics of metastable austenitic steels were investigated. The results indicate unusual combinations of strength and ductility for the steels in a certain carbon range after suitable thermomechanical processing. The strength and ductility were retained at -196°C to 100°C. However, at 200°C, which is above M_D, the material exhibited lower ductility. A CDC 6600 computer (Fortran IV) was used to determine the true stress-true strain relationship and strain hardening exponent. Certain thermo-mechanical treatments produced steels having yield strengths in the range of 200,000 to 300,000 psi with 30 to 20% elongation, respectively. The improved ductility for these steels compared to conventional high strength steels is attributed to the martensitic transformation occurring during testing which is thought to inhibit incipient necking. (auth)

661 CONTROL OF HYDRIDE ORIENTATION IN ZIRCALOY BY FABRICATION PRACTICE. Marshall, R. P. (E. I. du Pont de Nemours and Co., Aiken, S. C.). Contract AT(07-2)-1. J. Nucl. Mater., 24: 49-59(1967). (DP-MS-66-34).

Preferred orientations of hydride platelets formed in seamless Zircaloy tubing were related to the process variables of tubing fabrication. The preferred hydride orientations were described by computer-analyzed frequency distributions of the orientations

of individually counted platelets. Nine samples of tubing were studied. Results of analyses indicated that the hydride orientations in the transverse and longitudinal tubing planes were primarily related to the three-dimensional strain history of fabrication. A new parameter termed the "Directional Strain Parameter" (D&P) was developed to analyze and express fabrication strains. The relationship between D&P and hydride orientation appeared to correlate satisfactorily for rolled plate as well as seamless tubing. The type of fabrication process did not appear to be significant except for its effect on strain history. The mechanism of hydride platelet orientation inferred from these results is discussed. (auth)

662 INFLUENCE OF FABRICATION HISTORY ON STRESS-ORIENTED HYDRIDES IN ZIRCALOY TUBING. Marshall, R. P. (E. I. du Pont de Nemours and Co., Aiken, S. C.). Contract AT(07-2)-1. J. Nucl. Mater., 24: 34-48(1967). (DP-MS-66-31).

The stress orientation of hydride platelets and crystalline textures of seamless Zircaloy tubing were related to the fabrication history. Stress-induced changes in preferred hydride orientations were measured with applied tensile and compressive stresses in the three major tubing directions. Changes in preferred hydride orientations were determined from frequency distributions of individual hydride platelets as measured with specially designed equipment. The susceptibility to stress-orientation of the hydrides was very high for the hot-reduced tube; essentially 100% of the hydrides were reoriented at moderate stress levels. In contrast, the stress-orientation susceptibility was lower and very similar for all cold-reduced tubing, i.e., tubing fabricated by reducing the diameter at ambient temperature. Thus, susceptibility to stress-orientation of the hydrides appeared to be a characteristic of the type of reduction, i.e., hot-reduced or cold-reduced, and was not dependent on the amount of reduction in diameter or wall thickness during fabrication. On this basis, the susceptibility to stress orientation of hydride platelets that was observed for these cold-reduced tubes can be applied to a first approximation to other cold-reduced tubes. Hydride-orientation distributions and stress-orientation susceptibilities could not be related to Zircaloy texture. Habit planes for the hydrides are discussed. (auth)

663 CRUCIBLE-FREE ZONE MELTING OF HIGH-MELTING METALS WITH THE AID OF POINT-FOCUSED ELECTRON BEAMS. Bas, Enis B.; Stevens, Hugo (Technische Hochschule, Zurich). Z. Angew. Math. Phys., 18: 747-57(Sept. 25, 1967). (In German).

In conventional systems for floating-zone melting with electron bombardment the use of ring-cathode electron guns is widely spread. However, little is known about the applicability of point-focus electron-beams for floating-zone melting. To study this type of process a floating-zone melting device with a horizontal specimen position and a single point-focus electron-beam has been constructed. The experiment showed that, in spite of sagging of the molten zone due to gravity, it is possible to melt rods of all refractory metals with rod diameters up to 5 mm with well controllable operating characteristics. This method easily allows the growth of exactly oriented crystals of W, Ta, Mo and Nb using a goniometric holder with a seed crystal on one side. Some characteristics of this type of zone melting and some preliminary results of an investigation of the single crystals grown in this way are discussed. (auth)

664 DEFORMATION OF ZIRCALOY-2. Tyson, W. (Univ. of Toronto). J. Nucl. Mater., 24: 101-3(1967).

It is shown by comparison with pure zirconium-oxygen alloys that deformation of single crystals of Zircaloy-2 is controlled by oxygen impurities, possibly with a small athermal contribution from solution and precipitation hardening. The strength of polycrystals contains a contribution from the grain boundaries which can be largely due to the refinement of grain size by precipitates. (J.C.W.)

665 STUDIES ON THE MECHANICAL PROPERTIES OF HOT EXTRUDED BERYLLIUM AT ELEVATED TEMPERATURES. Sato, Sennosuke; Oku, Tatsuo (Japan Atomic Energy Research Inst., Tokyo). Zairyo, 16: 203-9(Mar. 1967). (In Japanese).

Hot extruded Be of reactor grade purity was studied at elevated temperatures with respect to its tensile, hardness, elastic modulus and creep properties. The results are discussed in comparison with a previous report regarding hot rolled Be. The hardness was regarded as a macroscopic measure for the temperature dependencies of critical slip mechanisms in single crystals. The elastic modulus up to 1,000°C was determined by means of ultrasonic pulse propagation speed. The creep tests were carried out in two ways, namely the stress increment method at constant temperatures from room temperature to 700°C and the temperature cycling method of the triangular temperature variation between 350 and 600°C at constant loads. In the stress increment creep, the steady creep rate and the rupture life in the Larson–Miller diagrams agree reasonably with the corresponding data of The Brush Beryllium Co. by ordinary methods. The relation of steady creep rate $\dot{\epsilon}$ and the cycles-to-rupture N_R in the temperature cycling creep was expressed as $\dot{\epsilon}N_R^{0.70}$ = constant. This equation is similar to the formula on strain controlled fatigue. The considerations in the temperature cycling creep of this material are discussed in comparison with constant temperature creep. (auth) (NSA of Japan)

666 STUDIES ON THE MECHANICAL PROPERTIES OF HOT ROLLED BERYLLIUM AT ELEVATED TEMPERATURES. Sato, Sennosuke; Oku, Tatsuo (Japan Atomic Energy Research Inst., Tokyo). Zairyo, 16: 194-202(Mar. 1967). (In Japanese).

The effects of high temperature and neutron irradiation on the mechanical properties of hot pressed and unidirectionally rolled Be, produced by powder metallurgy, are discussed with respect to improvement for use as fuel cladding material. (TSS) (NSA of Japan)

667 STABLE ISOTOPE-DILUTION TECHNIQUES FOR THE DETERMINATION OF GASES IN METALS. Masson, C. R. (National Research Council of Canada, Halifax). Metals Mater., 1: 147-68(Oct. 1967).

There is an increasing interest in new means for the determination of gases in metals. The purpose of this review is to summarize the principles involved in the method of stable isotope dilution and to outline the techniques so far employed by investigators in this field. The limitations of the method, as well as its advantages, are discussed and the results compared, when possible, with those obtained by other methods of analysis. (50 references) (auth)

668 IDENTIFICATION OF RHENIUM IN TUNGSTEN–RHENIUM ALLOYS USING THE FIELD-ION MICROSCOPE. Elvin, C. D. (General Electric Co., Wembley, Eng.). Phil. Mag., 16: 35-43(July 1967).

A series of tungsten–rhenium solid solution alloys was examined using a helium field-ion microscope. The micrographs show that during field evaporation of these alloys the rhenium atoms are less readily removed by field evaporation and remain on the surface. The effect is most noticeable on the {011} net planes and explains the poor perfection of the field-evaporated end-form seen in the higher rhenium content tungsten–rhenium solid solution alloys. (auth)

669 SOME PROPERTIES OF STRONTIUM HAFNATE AND ZIRCONATE. Berezhnoi, A. S.; Bilik, V. Ya. (Scientific Research Inst. of Refractory Materials, Kiev). Dopov. Akad. Nauk Ukr. RSR, Ser. B, No. 8, 708-10(Sept. 1967). (In Ukrainian).

Comparative characteristics are given and analyzed of the properties of stronium hafnate and zirconate, including their melting points (3163°K and 3023°K respectively), coefficients of thermal expansion (9.9 and $10.0 \cdot 10^{-6}$), refractive indexes (2.11 and 2.08) in comparison with the properties of a series of other super-refractory oxide compositions. It is noted that $SrHfO_3$ and $SrZrO_3$ are promising for the application in high-temperature technology for the non-mass production. (auth)

670 SINGLE-CRYSTAL ELASTIC PROPERTIES OF TUNGSTEN FROM 24 TO 1800°C. Lowrie, Robert; Gonas, A. M. (Union Carbide Research Inst., Tarrytown, N. Y.). J. Appl. Phys., 38: 4505-9(Oct. 1967).

The velocities of ultrasonic shear and compressional waves in tungsten crystals have been measured in several directions and as functions of temperature to 1800°C. Adiabatic crystal elastic stiffnesses have been calculated from these velocities. Values for the elastic constants of random, polycrystalline tungsten were calculated from these crystal stiffnesses. They agree well with values determined on polycrystalline tungsten as functions of temperature. (auth)

671 DUCTILE-TO-BRITTLE TRANSITION TEMPERATURE OF TUNGSTEN–MOLYBDENUM ALLOYS. Gavrilyuk, M. I.; Ershova, V. T.; Gorbodei, A. T. Fiz. Metal. Metalloved., 23: 944-5(May 1967). (In Russian).

The effect of molybdenum content on the ductile-to-brittle transition temperature of tungsten–molybdenum alloys has been investigated. Several alloys containing 1 to 80 at. % molybdenum were melted and the obtained ingots were hot-deformed with 70 to 85% reduction. Specimens (5 mm in diameter and 25 mm long) of the alloys, fully annealed in vacuum at 1800°C for 1 hr, were tensile tested at 200 to 600°C. It was found that increasing molybdenum content, up to about 3 at. %, decreases the ductile-to-brittle transition temperature. At about 10 at. % of molybdenum the transition

temperature begins to increase rapidly and reaches its maximum at about 50 at. % molybdenum. With further increase of molybdenum content, the transition temperature drops again approaching that which is characteristic for unalloyed molybdenum. (ATD)

672 TRANSVERSE MAGNETORESISTIVITY OF α AND β PLUTONIUM. Brodsky, Merwyn B. (Argonne National Lab., Ill.). Phys. Rev., 163: 484-7(Nov. 10, 1967).

Transverse magnetoresistivity measurements have been made on pure polycrystalline α and β plutonium. The magnetoresistivity of both phases is negative at 5°K and low applied fields, and becomes positive at fields greater than 2000 G. The negative effect decreases with increasing temperature and is not dependent on sample texture. The higher-field results follow the H^2 dependence found in "normal" metals. It is concluded that the negative effect is due to magnetic ordering, which results from s-f exchange, and the Néel temperatures are near 20 to 30°K for both phases. The high-field data are consistent with earlier models in which the electrical conductivity is dominated by a small number of holes in the 7s band. (auth)

673 COMPARISON OF THE MECHANICAL PROPERTIES AT HIGH TEMPERATURES AS A FUNCTION OF THE RATE OF STRESSES. Pomey, G.; Grumbach, M.; Rabbe, P. (IRSID, Saint-Germain-en-Laye, France). Rev. Met. (Paris), 64: 447-60(May 1967). (In French).

On seven steels hot traction tests in a wide range of deformation rates, Vickers hardness test as a function of the temperature, and endurance tests in rotative bending at high temperatures and for two frequencies of cycles corresponding to a normal rotation and to a very low rate were carried out. The results obtained showed that all the fields tested between 20 and 400°C have a maximum of resistance to traction, a hardening peak, and an increase of their endurance which depends on the deformation rate. This phenomenon, which is produced even in the case of variations not susceptible to aging after α tempering, was attributed to an aging accompanying the plastic deformation at the test temperature. Comparison of the results obtained made it possible to connect the hardness measurement and the duration under cyclic stress to traction characteristics by taking into consideration the temperature of the test and the actual deformation rate. (tr-auth)

674 CONTRIBUTION TO THE STUDY OF THE OXIDATION OF Zr AND THE DIFFUSION OF O_2 IN THE OXIDE AND IN THE METAL. Debuigne, Jean. Metaux (Corros.-Ind.), 42: 186-203(May 1967). (In French).

Physical and mathematical models of the oxidation mechanism for Zr were developed on the basis of the experimental results previously described. The mathematical equations derived were used to calculate the diffusion coefficients of O_2 in the metal and in monoclinic zirconia at different temperatures. (J.S.R.)

675 TUNGSTEN AND MOLYBDENUM POROUS PARTS. Ponomarenko, E. P.; Voropaev, A. K. (Ukrainian Scientific-Research Inst. of Special Steel, Kiev. Inst. of Problem of Material Management, Kiev). Porosh. Met., Akad. Nauk Ukr. SSR, No. 9, 92-6(Sept. 1967). (In Russian).

Effects of technological factors on the porosity of sintered W and Mo were investigated. Air penetration and durability of the sintered Mo and W parts are considered in relation to their porosity. (auth)

676 STATE OF THE NORMALIZATION OF METALLURGICAL PRODUCTS IN FRANCE AND ABROAD. II. Delbart, G.; Rousseau, P. (Bureau de Normalisation de la Sidérurgie, Paris). Rev. Met. (Paris), 64: 415-35(May 1967). (In French).

The specifications relative to steels for reinforced concretes and steels produced for wire drawing are evaluated. The quality norms for special steels: alloyed steels for boilers, steels for pressure devices working at low temperature, and steels for thermal treatment, were studied in particular. The dimension norms and the dimension tolerance norms of these products were compared. (tr-auth)

677 PRECIPITATION OF NITRIDE IN NIOBIUM (COLUMBIUM) AND NIOBIUM–ZIRCONIUM ALLOYS. de Lamotte, E.; Huang, Y.; Altstetter, C. (Univ. of Illinois, Urbana). Trans. Met. Soc. AIME, 239: 1625-30(Oct. 1967).

N_2 was introduced into pure Nb and dilute Nb–Zr alloy wires by equilibration with pure N_2 at high temperatures. Room-temperature hardness was correlated with the alloy composition, heat treatment, and microstructure. Hardness was found to be most sensitive to the amount of N_2 in solution; however, a significant hardening up to 500 dph took place upon aging of quenched alloys. A coarse dispersion of nitride did not significantly increase the hardness of the material though the nitride was found to have a hardness of 1400 Khn. High-N_2 alloys cleaved on {100} planes and had negligible ductility. Precipitation was found to occur in either a discontinuous or a continuous fashion, depending on the composition and cooling rates. Upon cooling, the precipitation first proceeded discontinuously by the nucleation of nitride needles at subboundaries and subsequent growth of a two-phase microconstituent. At lower temperatures continuous precipitation occurred in the subgrain interior ahead of the discontinuous precipitation interface. (auth)

678 TENSION–COMPRESSION FATIGUE TESTS ON A Co–Cr–W–Ni ALLOY IN TEMPERATURE RANGE OF 800 TO 1200 C. Hillnhagen, Emil; Hempel, Max. Arch. Eisenhuettenw., 37: 511-22(June 1966). (In German).

Specimens of Cronidur 600 (50% Co, 20% Cr, 15% W, 10% Ni, 3% Fe, 1.5% Mn, 0.5% Si, 0.1% C) were tested in air with newly developed high-temperature tensile and fatigue testing apparatus. Fatigue tests were performed with unnotched specimens at a frequency of 2400 cycles/min at room temperature and at 800 to 1200°C to 50-million reversals. Wohler curves obtained at room temperature and 800°C showed a horizontal branch of the curve to the abscissa. Between 900 and 1200°C, the lines were straight and declined toward the abscissa, without reaching the limit of endurance. In tensile tests, the saw-tooth-like configuration of the stress-strain curves was of interest at 600, 700, and 800°C. The fatigue strength ratio, i.e., the ratio of the tensile-compression fatigue strength for 300 hr to the high-temperature tensile strength was approximately 0.46 at 20 and 800°C and declined at 900, 1000, and 1100°C to 0.40, 0.36, and 0.30. At 1200°C, the ratio was based on 100 hr and was 0.10. Specimens failing at 20 and 800°C showed slipping in the microstructure and transcrystalline crack propagation. At 900°C, fatigue cracks appeared both at the grain boundaries and in the grains. At 1000 and 1100°C, oriented precipitates were observed, with both inter- and transcrystalline crack propagation, followed by destruction of the structure through grain boundary oxidation. (Rev. Met. Lit.)

679 THERMAL CONDUCTIVITY OF THE BORIDES OF TRANSITION METALS OF THE IV–VI GROUPS IN THE PERIODIC TABLE. L'vov, S. N.; Nemchenko, V. F.; Mal'kov, P. I. pp 451-5 of Vysokotemperaturnye Neorganicheskie Soedineniya. Kiev, Nauk Dumka, 1965. (In Russian).

Thermal conductivity at room temperature was determined for metals of the IV to VI groups in the periodic table and their borides: TiB_2, VB_2, Cr_4B, Cr_2B, CrB, CrB_2, ZrB_2, NbB_2, Mo_2O_5, HfB_2, TaB_2, and W_2B_5. The nature of the change in thermal conductivity can be explained by the contribution of the electron and phonon thermal conductivities to the general thermal conductivity. On changing from the metals of the IV group to the metals of the V and VI groups, thermal conductivity of the diborides decreases. This can be explained by a decrease in electron thermal conductivity. The higher values of thermal conductivity of the diborides of metals of the IV group compared with that of pure metals are due to the noticeable intensification in electron and in phonon thermal conductivities. However, the thermal conductivity in metals of the V and VI groups is substantially higher than in their borides. The increase in thermal conductivity in Cr borides with an increase in B content is connected with the increase in phonon thermal conductivity, which is due to the intensification in the interatomic binding B–B. The Lorentz number for the transition metal borides is considerably higher than the theoretical as a result of the substantial lattice contribution to the general thermal conductivity. (Rev. Met. Lit.)

680 SOFT X-RAY SPECTROMETRY AND ITS ROLE IN THE ELECTRON THEORY OF METALS AND ALLOYS. Ellwood, E. C.; Fabian, D. J.; Watson, L. M. (Univ. of Strathclyde, Scotland). Metals Mater., 1: 333-9(Oct. 1967).

A fully satisfactory electron theory of metals and alloy phases has so far eluded the metallurgist and physicist, but soft X-ray emission spectra can be expected to play an important part in the eventual formation of such a theory. (auth)

681 EFFECT OF PREDEFORMATION AT 400°C ON THE MECHANICAL PROPERTIES OF POLYCRYSTALLINE BERYLLIUM AT 50, 100, AND 200°C. Carpentier, D.; Daumas, R.; Francois, D. (CEA, Bruyeres-le-Chatel, France). J. Nucl. Mater., 23: 320-35(1967). (In French).

Specimens of polycrystalline Be, prestrained at 400°C, were pulled in tension at 50°, 100°C and 200°C. Prestraining does not improve ductility at 50 and 100°C, whereas 1% prestrain at 400°C increases elongation from 25.8 to 31.8% at 200°C. A comparison of the stress strain curves suggests that Be obeys a mechanical equation of state. At 200°C cracks which are initiated in the specimens, are blocked at grain boundaries. (auth)

682 ATMOSPHERIC OXIDATION OF UNALLOYED PLUTONIUM AT LOW HUMIDITIES. Raynor, J. B.; Sackman,

J. F. (Atomic Weapons Research Establishment, Aldermaston, Eng.). J. Nucl. Mater., 23: 302-8(1967).

The rate of oxidation at 90°C of unalloyed Pu over eleven different desiccants has been measured. The results confirm the sigmoidal shape of the oxidation rate versus relative humidity curve and place the position of the "knee," which indicates the level below which the humidity must be reduced to obtain a significant decrease in oxidation rate, at about 2%. The vapor pressure (of water) above the desiccants used has been determined at 90°C. (auth)

683 INVESTIGATIONS ON THE NIOBIUM–OXYGEN–NITROGEN SYSTEM. I. CHANGES OF PROPERTY ON NIOBIUM BY DISSOLVED OXYGEN–NITROGEN MIXTURES. Gebhardt, Erich; Rothenbacher, Rolf; Kvernes, Ingard (Max-Planck-Institut fuer Metallforschung, Stuttgart). Z. Metallk., 58: 703-8(Oct. 1967). (In German).

In order to determine the changes of property of Nb caused by O_2-N_2 mixtures dissolved in the metal, wire samples of a purity exceeding 99.85 wt. % and of 0.8 mm dia. were almost completely degassed under high vacuum at 2300°C within 10 minutes. This state was controlled by means of measuring electrical resistivity, magnetic susceptibility, and hardness. Following these tests, the samples were loaded with varying amounts of N_2 and O_2 at 1760 and 1460°C respectively, under a pressure of $5 \cdot 10^{-3}$ torr, homogenized, and rapidly cooled in Ar. Subsequent to this, the different properties of the material were determined. The electrical resistivity of Nb increases almost linearly with the amount of the O_2-N_2 mixture dissolved in the metal lattice. The temperature-independent additional resistivity amounts to approx. 4.1 μΩ cm per atomic percent of dissolved gas. Specific magnetic susceptibility decreases at room temperature with a gas absorption of 4.5 at. % from $2.28_3 \cdot 10^{-6}$ cm³ per g to $2.05 \cdot 10^{-6}$ cm³/g. Microhardness (measured at a load of 50 grams), however, increases from 64 kg/mm² for a degassed sample to approx. 525 kg/mm² at a gas content of 4.5 at. %. Thereby the influence of N_2 in solution on the hardness of Nb is greater than that of oxygen. This result agrees well with measurements of the lattice parameter according to which nitrogen expands the metal lattice more markedly than oxygen does. The rate of oxygen absorption of Nb at 1460°C and $5 \cdot 10^{-4}$ torr of O_2 depends under these conditions on the N_2 content. The reaction constant k for the linear time dependence of the O_2 absorption amounts to approx. 0.10_8 mg/cm² min for pure Nb. With a sample containing 0.4 at. % N_2, however, the reaction constant amounts to only 0.08_5 mg/cm² min. Furthermore, the maximum O_2-N_2 content that can be homogeneously kept in solution with rapid cool-down of the samples, was determined. This was effected by measuring resistivity in the cold state on samples first loaded with N_2 at 1760°C and subsequently with oxygen at temperatures ranging from 1000 to 1525°C. It was found that the maximum amount of gas that can be kept in solution depends on the temperature of the sample at the beginning of the cool-down. For N_2 contents between 0.3 and 0.7 at. %, the total amount of gas in solution increases from 2.1 at. % for a temperature at the beginning of the cool-down of 1000°C to approx. 4.8 at. % for a starting temperature of 1460°C. From these values it may be taken that the maximum gas concentrations that can be kept in solution in quenched samples are approximately equal for the two systems $Nb-O_2$ and $Nb-O_2-N_2$. According to this, O_2 may—within certain limits—be substituted by N_2. (auth)

684 DEFORMATION OF TANTALUM–NIOBIUM AND TANTALUM–MOLYBDENUM SINGLE CRYSTALS. Rudolph, G.; Mordike, B. L. (Univ. of Liverpool). Z. Metallk., 58: 708-13(Oct. 1967).

The effect of additions of Nb and Mo to Ta was studied. Nb produced very little hardening, whereas Mo produced a significant hardening. The basic deformation mechanism of Ta was unaffected by alloying at low temperatures although both Mo and Nb had a slight effect at ~200°K and Mo extended the stress sensitivity to ~600°K. (auth)

685 HEAT RESISTANCE PROPERTIES OF W–Mo ALLOYS. Gavrilyuk, M. I.; Ershova, V. T.; Mikheev, N. I. Metalloved. Term. Obrab. Metal., No. 7, 57-9(July 1967). (In Russian).

The properties of cast and deformed alloys with 0.5 to 67 wt. % Mo (1 to 80 at. %) were investigated. The data showed that the alloying of W with Mo up to 10 to 15 wt. % significantly increases not only its mechanical properties in the low-temperature region but its heat resistant properties at 1,500 to 1,700°C in the recrystallized state. At temperatures near 2,000°C the effect of Mo on the heat resistance properties of W becomes very insignificant. (tr-auth)

686 THEORY OF HEAT RESISTANCE ALLOYING. Vasil'eva, E. V.; Prokoshkin, D. A. (Inst. of Metallurgy, Moscow. Moscow School of Tech.). Metalloved. Term. Obrab. Metal., No. 8, 2-7(Aug. 1967). (In Russian).

The temperature dependence of self diffusion constants of 14 metals (W, Mo, Cr, Ta, Nb, V, Fe, Co, Ni, Cu, Ag, Au, Ti, and Zr) was constructed as a homological function of temperature. The experimental peaks on the diagram were found by isotopic method. The obtained data indicated that the diffusion mobility metals in solid solutions are in agreement with homological diffusion laws. Creep curves for Nb–W alloys reveal the least creep at 1100°C; the diffusion mobility of Mo at 1100°C was higher than that of W. (R.V.J.)

Structure and Phase Studies

Refer also to abstract 54.

687 (AD-645762) EFFECT OF CARBON ADDITIONS ON THE SHEAR MODULUS OF TUNGSTEN–3 PERCENT RHENIUM ALLOY. Interim Technical Report. Kay, D. R.; Scala, E. (Cornell Univ., Ithaca, N. Y.). 1966. Contract DA-31-124-ARO(D)-228. 22p. CFSTI.

Chemical interactions of rhenium and carbon with the tungsten matrix were studied by observing changes in shear modulus with composition. The addition of 3% rhenium to tungsten decreased the shear modulus from 19,6000,000 psi to 16,100,000 psi. Carbon additions did not change the modulus of the pure tungsten, but 70 ppM carbon increased that of the alloy to 18,700,000 psi. The observed alloying behavior was correlated to the electronic structure. The changes in modulus were attributed to changes in the electronic structure of the metal upon alloying. Differences in the behavior of carbon in the pure tungsten and the alloy were related to an increased carbon solubility in the alloy which in turn is a function of the electronic structure of the metal. (auth)

688 (AD-646682) TWINNING AND THE LOW TEMPERATURE MECHANICAL PROPERTIES OF POLYCRYSTALLINE COLUMBIUM, MOLYBDENUM, AND NbMo ALLOYS. Interim Technical Report, February 1, 1966–January 31, 1967. Shaw, B. J. (Westinghouse Electric Corp., Pittsburgh, Pa.). Contract Nonr-4442(00). 40p. (67-9F7-119-R1). CFSTI.

Results of the mechanical tests, in compression, tension, and by stress relaxation, on niobium neutron-irradiated and non-irradiated molybdenum, and three NbMo alloys are discussed. The tests were made at 200 to –269C, which covers the ductile-brittle transition temperature of all the polycrystalline materials used. The results indicate that point defects in the crystal lattice inhibit dislocation multiplication mechanisms, thereby increasing the yield and twinning stresses and enhancing the embrittlement. Etch-pit and electron microscopy studies in niobium are described. A theoretical investigation of slip on the b.c.c. (110) and (112) planes is also given. (TAB)

689 (CALT-221-34) AN APPLICATION OF THE THEORY OF PARTICLE COARSENING: THE γ' PRECIPITATE IN Ni–Al ALLOYS. Report No. 52. Ardell, A. J. (California Inst. of Tech., Pasadena. W. M. Keck Lab. of Engineering Materials). Aug. 1967. Contract AT(04-3)-221. 19p. Dep. CFSTI.

Coarsening of the γ' precipitate in binary Ni–Al alloys containing 6.35 and 6.50 wt. % Al has been studied by measuring the ferromagnetic Curie temperature as a function of ageing time at 625 and 715°C. The concentration of Al is linearly related to $t^{-\frac{1}{3}}$ at long ageing times, in agreement with theory. Analysis of the kinetics has provided values of c_∞, the concentration of Al in equilibrium with a γ' particle of infinite size. The values of c_e are about 10% larger than the literature values of the solubility at the relevant temperatures. This suggests that the present values of c_e represent the coherent solubilities. The results are used to exemplify a method for obtaining reliable values of the particle-matrix interfacial free energy, γ, and the "effective" diffusivity of the solute in the matrix, D_{eff}. As a result of the proposed method, the value of γ has been revised to approximately 14 erg/cm² from a previous estimate of 30 erg/cm². The value of D_{eff} is greater than the (extrapolated) coefficient of diffusion of Al in very dilute Ni by a factor of about two. D_{eff} is also a factor of two greater than that predicted by the application of irreversible thermodynamics to the process of volume-constrained growth and ungrowth of coherent precipitates during coarsening. (auth)

690 (LA-DC-8804) LIQUID STRUCTURE AS DEDUCED FROM PRECISE THERMODYNAMIC MEASUREMENTS. Elliott, Guy R. B.; Conant, Donald R.; Swofford, Harold S. Jr.; Houseman, Barton L. (Los Alamos Scientific Lab., N. Mex.). [1967]. Contract W-7405-eng-36. 35p. (CONF-670935-4). Dep. CFSTI.

From 3rd International Symposium on High Temperature Technology, Pacific Grove, Calif.

Recently new techniques have been developed and older techniques have been improved so that changes of thermodynamic

activity with composition can now be followed rather precisely in certain alloy systems. A general picture is presented regarding the information of this type which has been developed. The measurements have demonstrated that, although certain alloy systems may be fitted by simple models, in many other cases these solutions are far more complicated than many theories have assumed. In effect, the ordering forces of enthalpy and bonding may often be far more predominant than the randomizing forces related to temperature and entropy, and solid-like models seem called for to describe the short-range order in many strongly-bonded liquid alloys. The activity-mole fraction plots, which have often been treated as smooth curves, can frequently be shown to be series of almost linear segments. Sometimes these segments connect with other segments by rather sharp changes of slope. Even certain precise measurements of the water activity for ionic solutions show this behavior. In other cases regions of unchanging activity (liquid two-phase regions) connect these segments. Information used includes vapor pressure measurements using isopiestic balances, concentration cell emfs, electrical conductivity, and freezing point depression. (auth)

691 (NAA-SR-12353) BIAXIAL STRESS-RUPTURE PROPERTIES OF AUSTENITIC STAINLESS STEELS IN ZIRCONIUM-GETTERED SODIUM. Lee, W. T. (Atomics International, Canoga Park, Calif.). Oct. 1, 1967. Contract AT(04-3)-701. 40p. Dep. CFSTI.

The effect of a liquid metal environment upon the creep rupture of austenitic stainless steel was studied. Type 304 stainless steel containing 10 to 15% cold-work was tested in zirconium-gettered high purity sodium at 1300 and 1400°F for periods up to 1000 hr. Annealed Type 316 stainless steel was tested in zirconium-gettered high purity sodium at 1350°F for periods up to 1000 hr. For both austenitic stainless steels, the short-term rupture strength and rupture life of thin-wall tubing were found to be significantly lower in an environment of zirconium-gettered sodium than when tested in an atmosphere of helium. In the presence of sodium, the zirconium foil (inserted in the retort for oxygen-gettering) decarburized the stainless steel samples, thus reducing the stress-rupture strength and rupture life of the tubing. Recovery processes in the cold-worked Type 304 stainless steel specimens probably had an effect on the stress-rupture behavior. The formation of sigma phase was also detected, and is attributed to decarburization and the presence of cold-work. (auth)

692 (UCRL-17849) QUANTITATIVE INVESTIGATION OF STRAIN INDUCED STRENGTHENING IN STEEL. de Miramon, Bertrand (California Univ., Berkeley. Lawrence Radiation Lab.). Sept. 1967. Contract W-7405-eng-48. 48p. Dep. CFSTI

Thesis.

Effects of strain-induced austenite → martensite transformation on the mechanical properties and especially on the ductility of some metastable austenitic steels were investigated. The steels investigated were a new class of high nitrogen steels having yield strengths above 200,000 psi with 20 to 40% elongation. The results emphasize the important role of the austenite → martensite transformation in improving the ductility by preventing early necking. The austenite → martensite transformation was detected by a magnetic method. It was assumed that the saturation induction (B_s) was proportional to the amount of magnetic phase (martensite). The proportion of martensite in each specimen was measured during pulling using a permeameter attached to an Instron testing machine. The tests showed that martensite forms immediately after the yield point in a region of the specimen which is plastically deformed. Some static measurements were also made on small portions cut from the tensile specimen. These measurements indicated that the austenite → martensite transformation seems to occur only in the plastic region which traverses the specimen. Finally, results of a few continuous (but nonquantitative) tests indicated that serrations observed in some tensile curves can be correlated with discontinuities in the martensite transformation. (auth)

693 (UCRL-Trans-10137) OSCILLOSCOPIC INVESTIGATION OF MARTENSITE FORMATION IN IRON-NICKEL ALLOYS-EXPLANATION OF ANOMALOUS POTENTIALS. Kimmich, Heinz; Wachtel, Ernst. Translated by Z. F. St-Gallay for Univ. of California Lawrence Radiation Lab., Livermore, from Arch. Eisenhuettenw., 35: 1193-1202(1964). 45p. Dep. CFSTI. JCL $4.60 fs, $1.55 mf.

The difference in the resistivities of two phases of a Fe–Ni alloy was utilized in the investigations of martensite formation. The changes in the resistance accompanying the transformation were recorded with the aid of an oscilloscope. This led to confirmation of the earlier observation that the potential across the specimen often does not fall monotonically, but that there is instead a minimum or a maximum in the voltage change at the beginning of the process. For the closer investigation of this anomalous behavior, an electronic measuring apparatus sensitive to both positive and negative potential-change pulses was used. The maxima and minima of the potentials have so far been attributed to changes in the resistance of the emerging martensite platelets, but are now ascribed to a change in the magnetic flux. This follows from experiments in which the specimens were placed in a magnetic field. The vertical disposition of the sample to the direction of the field together with the use of a special device resulted in an accurate answer to the question of the anomalous potentials. The investigations show beyond doubt that the maxima and minima in the potential have to do with induced potentials. The maxima and minima observed in the absence of an external magnetic field can also be attributed to changes in induced potentials. This explains the existence of three basic types of potential/time curves which appear according to the experimental conditions (i.e. curves with a monotonic fall, a minimum, and a maximum). The monotonic fall in the potential is due to the change in the resistance from that of austenite to that of martensite in the course of the phase transformation. The change in the temperature of the sample during and after the transformation must be taken into account. (auth)

694 AN INVESTIGATION OF THE ALUMINIUM-RICH ALLOYS IN THE ALUMINIUM–SAMARIUM–URANIUM AND ALUMINIUM–DYSPROSIUM–URANIUM TERNARY SYSTEMS. II. THE ALUMINIUM-RICH ALLOYS IN THE Al–Dy–U TERNARY SYSTEM. Casteels, F.; Diels, P.; Cools, A. (Studiecentrum voor Kernenergie, Mol, Belg.). J. Nucl. Mater., 24: 95-100(1967).

An isothermal section at 600°C of the aluminum-rich corner of the Al/U/Dy system, freezing sequence of some ternary alloys and the fabrication characteristics of Al/U/Dy alloys in the Al/24% U region are investigated. Micrographic and x ray methods, thermal and microprobe analysis are used in this investigation. One ternary intermetallic compound is identified as $U_2Dy_3Al_{15}$. A pseudobinary system $DyAl_2$–UAl_2 (cubic C15 $MgCu_2$ type) is found. The phase boundaries of the single-, two-, and three-phase alloys are determined; a region of insolubility in the liquid and solid state is delineated. Three intermetallic compounds are found to be in equilibrium with the aluminum-rich solid solution. The existence of three intermetallic solid solutions $(Dy,U)Al_4$, $(Dy,U)Al_3$ and $(Dy,U)Al_2$ is established. (auth)

695 AN INVESTIGATION OF THE ALUMINIUM-RICH ALLOYS IN THE ALUMINIUM–SAMARIUM–URANIUM AND ALUMINIUM–DYSPROSIUM–URANIUM TERNARY SYSTEMS. I. THE ALUMINIUM–URANIUM–SAMARIUM SYSTEM. Casteels, F.; Diels, P.; Cools, A. (Studiecentrum voor Kernenergie, Mol, Belg.). J. Nucl. Mater., 24: 87-94(1967).

An isothermal section (at 600°C) and some melting points in the aluminum-rich corner of the Al/U/Sm system is investigated by differential thermal analysis, micrographic examination, x ray and electron microprobe analysis and thermal diffusion studies. No ternary intermetallic compound is found in the investigated composition range. The phase boundaries of the existing single-, two- and three-phase alloys are determined. The variations with composition of the lattice parameters in the pseudobinary system $SmAl_2$–UAl_2 are determined. An orthorhombic $(U,Sm)Al_4$ intermetallic compound is found to be in equilibrium with the aluminum-rich solid solution. From this study, it is possible to conclude that samarium can be homogeneously introduced in (U/Al) fuel alloys owing to the formation of the $(U,Sm)Al_4$, $(U,Sm)Al_3$ and $(U,Sm)Al_2$ solid solutions. (auth)

696 STABILITY AND AXIAL RATIOS OF VARIOUS CLOSE-PACKED STRUCTURES. Hodges, C. H. (Cavendish Lab., Cambridge, Eng.). Acta Met., 15: 1787-94(Dec. 1967).

The structural energy of various close-packed phases has been analyzed using the method of the interactions between pairs of close-packed planes. Using this method a correlation between the structure and the deviation of its axial-ratio from ideality, which exists in the rare-earths and in one or two other cases, is explained. The conditions for the appearance of complex phases such as the d.h.c.p. and Sm structures are described. (auth)

697 THE PROBLEM OF INTERMETALLIC COMPOUND ANALYSIS IN THE SYSTEM Nb–Sn WITH AN ELECTRON MICROPROBE ANALYZER. Kralik, Frantisek (Slovak Academy of Sciences, Bratislava). Fyz. Cas., 17: 115-20(1967). (In Czech.).

Experimental work to determine the most suitable conditions for analysis of intermediate phases in the system Nb–Sn with an electron microprobe analyzer is reported. It was shown that the NbK alpha line has the smallest correction. Using that spectral line it also is possible to consider pure Nb to be a satisfactory standard, as the resulting correction is less than 2%. Increase of the $I_{spectral}$

I_{line}/I_{noise} ratio needed for the analysis can be obtained by means of a lead slit. (JPRS)

698 CHANGES OF STRUCTURE IN THE OXIDE U_4O_9. Belbeoch, B.; Boivineau, J. C. (CEN, Saclay, France). J. Phys. Chem. Solids, 28: 1267-75(July 1967).

It was found that U_4O_9 shows a cubic-rhombohedric transition at 65°, in the temperature domain where anomalies of expansion and specific heat have previously been noted. At 1125° a rapid parameter variation was observed, together with disappearance of superstructure rays, indicating an order-disorder transformation. (UK)

699 DEFORMATION FAULTING IN TITANIUM, ZIRCONIUM, AND HAFNIUM. Lele, Shrikant; Anantharaman, T. R. (Banaras Hindu Univ., India). Phil. Mag., 15: 1035-6(May 1967).

An x-ray study of deformed Ti, Zr and Hf was performed. A Fourier analysis of line profiles revealed an absence of faulting in Zr and Hf, while a small deformation fault probability (0.008) was found for deformed Ti. The results are discussed in the light of earlier results and present theories on deformation faulting. (UK)

700 EXPERIMENTS ON THE DEFORMATION OF NIOBIUM SINGLE CRYSTALS. I. STRESS VERSUS STRAIN CURVES AND SLIP SYSTEMS IN COMPRESSION AND TENSION. Taylor, G.; Christian, J. W. (Oxford Univ.). Phil. Mag., 15: 873-92(May 1967).

Single crystals of niobium were purified by heating in high vacuum and then tested in tension or compression at various temperatures. Three-stage hardening curves were found at room temperature for single slip orientations, irrespective of whether the primary slip plane was of {101} or {211} type. An initial rapid hardening (stage 0) was also found for {101} slip, and was often associated with low or negative stage I hardening rates. Microstrain measurements showed that the much less pronounced stage 0 observed for {211} slip was mainly attributable to the initial build-up of plastic strain rate caused by machine softness. Another difference between {101} and {211} slip was the latent hardening on the conjugate slip plane, which caused large overshoot in tension when primary slip was on {101}, but not on {211}. At 158°K, stress versus strain curves were parabolic, except for ideal {211} single slip orientations tested in compression. At still lower temperatures, most crystals yielded by twinning (especially in compression), unless first pre-strained above 90°K. (UK)

701 EXPERIMENTS ON THE DEFORMATION OF NIOBIUM SINGLE CRYSTALS. II. ELECTRON MICROSCOPE STUDY OF DISLOCATION STRUCTURES. Taylor, G.; Christian, J. W. (Oxford Univ.). Phil. Mag., 15: 893-929(May 1967).

Thin foils were prepared from slices taken in selected orientations from crystals deformed in compression by single glide on $(\bar{1}01)$ or $(\bar{2}11)$ or by double glide on $(\bar{2}11)$ and (211). At room temperature the structures observed after single glide were quite similar to those which have been reported for copper. In stage I, braids in the primary slip plane consisted mainly of edge dislocation multipoles, but more complex tangles containing many secondary dislocations were formed in stage II, and were joined into the continuous walls of a cell structure. The main new feature observed in crystals orientated for double slip was the formation of high angle boundaries after large strains. Few screw locations were retained in the room temperature structures, but foils from crystals deformed at 158°K contained fairly uniform distributions of long primary screw dislocations, together with many small prismatic loops. It is believed that screw dislocations from different sources cross-slip and mutually annihilate at room temperature, but are prevented from doing this by the frictional stress at low temperatures. (UK)

702 SUPERPLASTICITY IN SOME TITANIUM AND ZIRCONIUM ALLOYS. Lee, D.; Backofen, W. A. (Massachusetts Inst. of Tech., Cambridge). Trans. Met. Soc. AIME, 239: 1034-40(July 1967).

The condition of superplasticity or neck-resistant flow that results from high strain-rate sensitivity has been observed in isothermal tension tests on several Ti alloys and one of Zr. In general, it was associated with reasonably fine-grain microstructures being strained in the transformation range at rates below $\dot{\epsilon} \simeq 10^{-3}$ sec^{-1}. The metallographic mean-free path, L, was measured at room temperature after rapid cooling from the temperature of testing. The flow stress of Ti-6Al-4V at 950°C was proportional to L^4 at different constant $\dot{\epsilon}$; the value of a decreased with increasing $\dot{\epsilon}$, but at $\dot{\epsilon} < 1.5 \times 10^{-4}$ sec^{-1} it varied only from 0.9 to 1.25. The findings were interpreted to mean that viscous boundary shear is the rate-controlling process of deformation at high levels of strain rate sensitivity in these materials. Elongation of over 1000 pct could be obtained, but at temperatures so high and rates so low that any practical application of the full effect would probably be difficult. As the transformation range was narrowed, by turning from Ti-6Al-4V to Ti-5Al-2.5Sn to nominally pure Ti, the allowable temperature variation was correspondingly reduced. Superplasticity was not found in Armco iron, presumably because the transformation range was too narrow to allow the development of a reasonably stable microstructure for isothermal testing. (auth)

703 GRAIN BOUNDARY DIFFUSION IN TUNGSTEN. Kreider, K. G.; Bruggeman, G. (Army Materials Research Agency, Watertown, Mass.). Trans. Met. Soc. AIME, 239: 1222-6(Aug. 1967).

Grain boundary diffusion coefficients were measured in W at 1400 to 2200°C and can be expressed by the equation $D_b = (3.33 \pm 0.15) \exp [-(92{,}000 \pm 2000)/RT]$ cm^2/sec. This activation energy confirms earlier estimates made from W sintering experiments. Grain boundary diffusion was found to occur in subboundaries having misorientations of less than 10 deg. The activation energy for this subboundary diffusion is equal to that for diffusion in incoherent grain boundaries within the limits of error. This is shown to be consistent with the dislocation model of low-angle boundaries where diffusion occurs along the dislocation pipes comprising the boundary. (auth)

704 THE SOLUBILITY OF NIOBIUM (COLUMBIUM) CARBIDE IN GAMMA IRON. Johansen, T. H.; Christensen, N.; Augland, B. (Technical Univ. of Norway, Trondheim). Trans. Met. Soc. AIME, 239: 1651-4(Oct. 1967).

Samples of an Fe–Nb alloy were brought to equilibrium with H_2–methane mixtures at 950 to 1050°C, and subsequently analyzed for C. The solubility product L = [%Nb] [%C] may be represented by the equation $\log L = -9290/T + 4.37$. Approximate solubilities indirectly assessed through hardness measurements have been included from a previous report. These data are shown to be in a fair agreement with the present solubility measurements. (auth)

705 INVESTIGATION OF RARE-EARTH METAL SINGLE CRYSTALS AND ALLOYS. Savitskii, E. M.; Terekhov, V. F.; Burov, I. V.; Naumkin, O. P. pp 41-50 of Metallovedenie Legkikh Splavov. Moscow, Nauka, 1965. (In Russian).

A study of the properties of rare earth metals and alloy phase diagrams was made. The phase diagrams of the Sc–Ce, Sc–Er, Y–Er, Cd–Gd, Nd–Pr, Gd–Tb, Gd–Er, Sc–Al, Y–Sn, and Fe–Nd systems was studied. The phase diagrams of the Sc–Er, Y–Er, Nd–Pr, Gd–Tb, and Gd–Er systems are of the same type and are characterized by the formation of a continuous series of solid solutions between the isomorphic modifications of the elements. In the Ce–Cs and Ce–Gd systems the high-temperature modifications formed fields of continuous solid solutions, and the low-temperature modifications formed solid solubility limits and two-phase fields. At room temperature approximately 17 at. % Sc and 0.5 at. % Gd dissolved in gamma Ce. The solubility of Ce in alpha Gd and alpha Sc was about 7 and 12 at. %, respectively. A Ce_3Gd_5 compound was formed in the Ce–Gd system. The Sc–Al, Y–Sn and Nd–Fe systems had in common a complete liquid solubility, a negligible solid solubility and the formation of compounds. The $ScAl_3$, $ScAl_2$, ScAl compounds were formed in the Sc–Al system. $ScAl_3$ and Sc_2Al were formed according to peritectic reactions at 1320 and 1300°C, respectively. At room temperature the solubility of Sc in Al was 0.5 at. %, and the solubility of Al in Sc was 4 at. %. A peritectic was formed on the side of Al at 665°C. The eutectics liquid $\rightleftharpoons$ $ScAl_2$ + ScAl and liquid $\rightleftharpoons$ alpha = Sc + Sc_2Al were formed at 1150°C and about 43 at. % Sc, and at 945°C and about 87 at. % Sc, respectively. The two compounds were possible in the Y–Sn system one containing 40% Sn formed from the melt at approximately 1880°C on the side of Y, and one containing about 67% Sn and forming according to the peritectic reaction at approximately 1120°C. The maximum solubility of Y in solid Sn did not exceed 0.3%. The formation of a eutectic at 1310°C and about 19% Sn on the side of Y was confirmed. The formation of a pseudoeutectic on the side of Sn was assumed. The compound $Fe_{17}Nd_2$ and a compound containing approximately 57% Nd(Fe_2Nd), the structure of which is not determined, were formed in the Fe–Nd system according to peritectic reactions. The eutectic liquid $\rightleftharpoons$ Nd + Fe_2Nd was formed at 640°C and 88.5% Nd. The solubility of Nd in alpha Fe and that of Fe in alpha Nd at room temperature was 0.3 to 0.4 and 0.1%, respectively. On examining the types of phase diagrams of alloys with rare-earth metals, some generalizations on the basic principles of rare-earth metal alloy formation were made. (Rev. Met. Lit.)

706 PROPERTIES AND STRUCTURE OF DEFORMED AND ANNEALED Mo. Krishtal, M. A.; Golovin, S. A.; Mokrov, A. P.; Shishkhanov, T. S.; Vitorskii, Ya. M. (Tula Polytechnical Inst., USSR). Metalloved. Term. Obrab. Metal., No. 7, 54-7 (July 1967). (In Russian).

The structure and properties of technically pure (99.6%) Mo were investigated. Rolling of Mo causes heterogeneity in the size of the granules. Strongly deformed fine granules were observed extending in the rolling direction and surrounded by coarse less deformed granules. Such a structure and the significant microdeformation in the area of coexistence of drawnout small granules surrounded by coarser granules can be the reason of stratification. Recrystallization diagrams of Mo were constructed. The elasticity modulus of Mo with different preliminary processing was determined during heating to 500°C. The maximum of the internal friction at 300°C in deformed Mo was determined at frequencies of 735 hertz and showed a relaxation of the deformation of the crystalline lattice. (tr-auth)

707 THE METALLURGY OF ALLOY 718. Hall, R. C. (Martin Co., Orlando, Fla.). J. Basic Eng., 89: 511-16(Sept. 1967).

The Ni-base wrought Alloy 718 was designed for high strength at elevated temperatures, that is, near 1200°F; the alloy also has exceptional mechanical properties at cryogenic temperatures. The metallurgy of Alloy 718 is presented. The effects of variations in composition, microstructure, and heat-treatment are correlated to mechanical properties; the relationships among these factors are complex and are described where possible. (auth)

708 AGING AND RECOVERY IN COLD ROLLED Zr–2.5 WT. PERCENT Nb ALLOY. Ells, C. E.; Cheadle, B. A. (Atomic Energy of Canada Ltd., Chalk River, Ont.). J. Nucl. Mater., 23: 257-69(1967).

Thick cold rolled sheet of a commercial heat of Zr-2.5 wt % Nb alloy has been used to study age hardening and recovery of the cold worked material. Both processes affect the strongly anisotropic mechanical properties in this material. The normal direction in the sheet exhibits a Bauschinger effect. Results from thick sheets of Zircaloy-2 and crystal bar Zr are used to demonstrate the effect of the Nb alloy addition. Conclusions by previous workers that aging in cold worked Zr-2.5 wt % Nb includes a competition between age hardening and stress relaxation are supported. However, crystallographic texture and Bauschinger effect must be considered carefully in any description of the aging process. (auth)

709 HYDRIDING ZIRCALOY-2 IN LITHIUM HYDROXIDE SOLUTIONS. Murgatroyd, R. A.; Winton, J. (United Kingdom Atomic Energy Authority, Warrington, Eng.). J. Nucl. Mater., 23: 249-56(1967).

The corrosion of Zircaloy-2 at 300°C in solutions containing from 5 to 72 g/l LiOH has been studied as a possible method of hydriding Zircaloy-2 pressure tubes. The results show that Zircaloy-2 can be hydrided uniformly to concentrations well above the solubility limit provided that a critical hydriding rate is not exceeded. This rate is increased by temperature cycling during corrosion, the optimum cycling conditions being to cool after each 60 ppm increment in the H_2 concentration. The amount of H_2 absorbed by the specimen is approximately 65% of that generated by the corrosion reaction and is not influenced by the thickness of the oxide film or the concentration of the LiOH solution. (auth)

Radiation Effects

Refer also to abstracts 688 and 773.

710 (AD–648742) RADIATION EFFECTS ON THIN-FILM MICROELECTRONICS. Final Report No. 5, July 15, 1965–October 14, 1966. Krueger, A. F.; Strahan, V. H. (Autonetics, Anaheim, Calif.). Feb. 1967. Contract DA-28-043-AMC-01467(E). 42p. (ECOM–01457-F). CFSTI.

The report describes the program to investigate the mechanisms of transient radiation effects on thin-film passive components. The effects under study include secondary emission effects, radiation-induced conductivity, memory and accumulated dose effects and damage by neutron irradiation. Radiation sources used were the 2 MeV and 600 keV flash X-ray machines, LINAC, and Fast Burst Reactor (FBR). A group of thin-film capacitors for studying the various effects was designed and fabricated. These capacitors were irradiated in air and in vacuum to determine the relative importance of the ambient environment on the total radiation-induced disturbance. Particular attention was paid to the effects of materials in the immediate proximity of the devices under study to determine methods of minimizing the effects of transient radiation. (auth)

711 (BMI–1809, Sect.B) IRRADIATION EFFECTS IN REACTOR CLADDING MATERIALS. (Battelle Memorial Inst., Columbus, Ohio). 42p.

The extent and nature of the irradiation-induced changes in the mechanical properties of AISI Type 347 stainless steel, Tenelon, Haynes Stellite-25 UMCo-50 and Nickel 200 were determined. These materials were evaluated for potential use as cladding materials for liquid-metal-cooled fast reactors. (F.S.)

712 (CU–3551-9) [NATURE OF RADIATION DAMAGE]. Final Report. (Columbia Univ., New York). [1967]. Contract AT(30-1)-3551. 4p. Dep. CFSTI.

The nature of metal radiation damage was studied with a field ion microscope and correlated with the mechanical properties, such as yield stress and annealing characteristics of the irradiated specimens. A list of publications and discussions on the subject is included. (F.S.)

713 (GEAP–4985) FAST NEUTRON DAMAGE STUDIES IN HIGH NICKEL ALLOYS. Busboom, H. J.; Mathay, P. W. (General Electric Co., San Jose, Calif. Atomic Power Equipment Dept.). Aug. 1966. Contract AT(04-3)-189. 55p. Dep. CFSTI.

The effects of fast reactor neutron irradiation upon the elevated temperature mechanical behavior of high nickel alloys were investigated. Tensile specimens of Incoloy 800, Inconel 625, and Hastelloy X were irradiated in the EBR-II Experimental Breeder Reactor at 1000°F to a neutron exposure of 3.3×10^{20} n/cm^2, E > 1 MeV. Post-irradiation tensile tests were performed at 78, 1100, and 1300°F and compared with similar tests on unirradiated coupons. It was found that exposure in EBR-II decreased elevated temperature ductility similar to that experienced by these alloys after thermal reactor exposure. Radiation-enhanced precipitation was also observed in Inconel-625 and Hastelloy-X. (auth)

714 (N–67–22957) HIGH-TEMPERATURE TENSILE PROPERTIES OF UNIRRADIATED AND NEUTRON IRRADIATED 20Cr–35Ni AUSTENITIC STEEL. Roy, R. B.; Solly, B. (Aktiebolaget Atomenergi, Stockholm (Sweden)). Dec. 1966. 26p. (AE–260). CFSTI.

The tensile properties of an unirradiated and neutron irradiated (at 40°C) 20% Cr, 35% Ni austenitic steel were studied at 650, 750, and 820°C. The tensile elongation and mode of fracture (transgranular) of unirradiated specimens tested at room temperature and 650°C are almost identical. At 750 and 820°C the elongation decreases considerably and a large part of the total elongation is nonuniform. Furthermore, the mode of the fracture at these temperatures is intergranular and microscopic evidence suggests that fracture is caused by formation and linkup of grain boundary cavities. YS and UTS decrease monotonically with temperature. Irradiated specimens show a further decrease in ductility and an increase in the tendency to grain boundary cracking. Irradiation has no significant effect on the YS, but the UTS are reduced. The embrittlement of the irradiated specimens is attributed to the presence of He and Li atoms produced during irradiation and the possible mechanisms are discussed. Prolonged annealing of irradiated and unirradiated specimens at 650°C appears to have no significant effect on tensile properties. (auth)

715 (UCRL–Trans–10135) PRECIPITATION OF HELIUM IN AN ALUMINUM–LITHIUM ALLOY. Levy, Viviane; Antolin, Jacqueline; Espinasse, Jacqueline; Adda, Yves (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Translated by Benjamin Thayne for Univ. of California Lawrence Radiation Lab., Livermore, from report CEA-R–2529. 52p. Dep. CFSTI. JCL $5.60 fs, $1.76 mf.

A study of radioinduced helium precipitation in aluminum-lithium alloys showed mechanisms of bubble germination and growth. The influence of the dislocation density on the bubble distribution, and that of the diffusion of the rare gas into the (planar or linear) defects on the growth of the bubbles were demonstrated. The results indicated that the presence of a stable polygonized structure can reduce the swelling when it is primarily due to a precipitation of bubbles at the grain boundaries. Precise knowledge is perhaps obtainable through exact density measurements on mon- or polycrystalline materials in which the density of the dislocations as well as their arrangement vary. It was also shown that under certain conditions the precipitation of rare-gas bubbles could prevent recrystallization of the metal through a mechanism based on the anchoring of the dislocations and grain boundaries by the bubbles. (auth)

716 THE POSSIBILITY OF IRRADIATION DAMAGE AFFECTING THE RATE-CONTROLLING MECHANISM OF SLIP IN BODY-CENTERED CUBIC METALS AND SOLID SOLUTIONS. Arsenault, R. J. (Univ. of Maryland, College Park). Contract AT(40-1)-3612. Acta Met., 15: 1853-9(Dec. 1967).

There have been numerous investigations of the rate-controlling mechanism for deformation in neutron-irradiated face-centered cubic metals, but there have been only a few preliminary experiments employing body-centered cubic metals. These experiments indicate that the neutron damage does not appear to change the rate-controlling mechanism of slip in b.c.c. metals. The reason for the absence of a change is due to the intrinsic rate-controlling

mechanism of slip in b.c.c. metals and the particular experimental conditions employed. These reasons are examined in detail and the probable experimental condition necessary for the observation of a detectable change in the rate-controlling mechanism is explored. (auth)

717 INFLUENCE OF IRRADIATION TEMPERATURE ON THE DAMAGE STRUCTURE IN NEUTRON-IRRADIATED MOLYBDENUM. Eyre, B. L.; Downey, M. E. (Atomic Energy Research Establishment, Harwell, Eng.). Metal Sci. J., 1: 5-8 (Jan. 1967).

A thin-film electron-microscope study was performed on a commercially pure and a zone-refined Mo, neutron-irradiated to a dose of 5×10^{19} n/cm^2 at 60 and 200°C. Visible damage clusters were present in all specimens, but more coarsely distributed in the purer material and after irradiation at the higher temperature. With zone-refined material irradiated at 200°C the damage was distinguishable as 2 components: coarsely distributed, irregular dislocation lines and a finer distribution of small dots up to 50 Å in dia. The results of loop analysis on annealed specimens indicated that the small dots were vacancy clusters. Dark-field analysis carried out on the small clusters, showed asymmetrical contrast in the zone-refined material irradiated at 60 and 200°C. The results indicated that these clusters, at least, were small loops. (BBB)

718 SOME EFFECTS OF NEUTRON IRRADIATION ON MARAGING STEEL. Cupp, C. R. (International Nickel Co., Inc., Suffern, N. Y.); Sadowski, E. P.; Trudeau, L. P. Trans. Met. Soc. AIME, 239: 1468-72(Sept. 1967).

The apparent high radiation resistance of two varieties of maraging steel is described and an indication is given of some phenomena that require further study. Two aspects were included in this work: effects of neutron irradiation on the room-temperature tensile properties of 18 Ni (250) maraging steel; effects of neutron irradiation on the room-temperature tensile properties and on the impact resistance of 12% Ni–5% Cr–3% Mo maraging steel. Subsize tensile and impact test specimens were used. The 18% Ni steel was irradiated to a neutron fluence of 3.3×10^{19} n per sq cm (>1 MeV). The 12-5-3 variety was irradiated to two neutron fluence levels: 1.5×10^{19} n per sq cm (>1 MeV); 3.1×10^{19} n per sq cm (>1 MeV). In all respects both varieties showed unusually high resistance to change in strength and ductility after neutron irradiation. There was no noteworthy over-aging in fully aged specimens. The aged 18% Ni variety showed a 4% drop in yield strength upon irradiation with little or no decrease in ductility. The aged 12-5-3 variety showed a 5% increase in yield strength on irradiation with a very slight decrease in ductility. The impact transition of the 12-5-3 variety only increased 35 to 45°C upon irradiation, and the shear energy fracture value for the subsized specimens decreased only half as much as expected from experience with conventional steels. (auth)

719 ELECTRON IRRADIATION HARDENING OF ALUMINUM–1 AT. PERCENT ZINC SINGLE CRYSTALS. Mifune, T. (Northwestern Univ., Evanston, Ill.); Meshii, M.; Ono, Kanji. Appl. Phys. Lett., 11: 282-3(Nov. 1, 1967).

Al–1 at. % Zn single crystals were tensile tested after 1 MeV electron irradiation near 20°K. The increase in the yield stress due to irradiation was proportional to the square root of the electron dose with a proportionality constant similar to that in Al. The strain rate sensitivity of the flow stress in stage 1 increased proportionally to the irradiation induced hardening. The electron irradiation hardening appears to be due to randomly dispersed interstitials acting as obstacles to the movement of dislocations. (auth)

Ceramics and Cermets

Refer also to abstracts 612–614, 1078, and 1914.

720 (BMI–1809, Sect.A) URANIUM–PLUTONIUM NITRIDE FUELS FOR LMFBR APPLICATIONS. (Battelle Memorial Inst., Columbus, Ohio). 96p.

An evaluation of U–Pu nitrides and carbonitrides for use as fuel material in fast breeder reactors is presented. The preparation, properties and effects of radiation on these materials were studied. Experimental studies of sodium boiling, film formation, and wetting are also reported. (F.S.)

Preparation and Fabrication

Refer also to abstracts 57 and 275.

721 (AD–646616) HIGH VISCOSITY THERMAL PROTECTION MATERIALS. Summary Report, June 30, 1965–June 30, 1966. Wilson, Roger E.; Caum, D. M. (Naval Ordnance Lab., White Oak, Md.). Dec. 16, 1966. 35p. CFSTI.

Processes were developed for hot pressing a 68.5% tungsten–31.5% silica composition to over 97% of the calculated theoretical density. Hot pressing characteristics changed when crystalline silica was substituted for vitreous silica. Grinding and hot pressing methods were studied for fabricating test nozzles for the NOL oxyhydrogen rocket motor. Gases entrapped during hot pressing are expected to be a factor in ablation performance. Vacuum-argon sintering of the silica-tungsten mixture was studied and photomicrographs revealed a structure similar to that of the Bjorksten Laboratory specimens but different from that of hot pressed material. (auth) (TAB)

722 (AD–648018) REACTIVELY SPUTTERED CERMET RESISTORS. Final Report, May 1965–May 1966. Lane, Clyde H.; Farrell, John P. (Rome Air Development Center, Griffiss AFB, N. Y.). Jan. 1967. 33p. (RADC-TR-66-783). CFSTI.

A dual cathode sputtering technique for creating thin cermet films is described. This technique was used to produce four types of mixtures: gold-tungsten oxide, platinum-tungsten oxide, platinum tantalum oxide, and gold tantalum oxide. Various resistor parameters are presented for all of the films. However, the emphasis is on the gold–tantalum mixtures which gave a zero temperature coefficient at approximately 6 to 8 thousand ohms per square sheet resistivity. A summation is presented on this work and suggestions for further efforts in this field are given. (auth) (TAB)

723 (AD–649537) HIGH-TEMPERATURE FIBERS AND CORE-SHEATH FIBER DEVELOPMENT. Final Report, September 1965–October 1966. Otto, William H.; Freske, Stanley (Whittaker Corp., San Diego, Calif. Narmco Research and Development Div.). Oct. 1966. Contract NOw-66-0110. 39p. CFSTI.

A composite ceramic-glass fiber of core-sheath configuration was formed by drawing the fiber from melts of the core and sheath materials metered through concentric orifices. The objective was to develop a continuous high-modulus (over 20 million psi) fiber produced by sheathing a high-modulus polycrystalline core material with a high-strength, high-temperature glass. Indirect heating was found to be most satisfactory on the basis of temperature control, bushing configuration, and fiber forming. Investigations of bushing materials proved that W was superior to BN and that high-alumina core materials which react with W should be contained in iridium. Research on high-modulus core materials included pure alumina, alumina modified with CaO and MgO, dispersions of high-modulus microcrystals and whiskers in a matrix glass and nucleating-crystallizing glass ceramics. Most promising were pure alumina, spinel (Al_2O_3–MgO), and calcium aluminates. W dual-melt brushing fiber forming studies disclosed a problem in interaction kinetics between the molten core and sheath materials, but this can be handled by appropriate concentric orifice design. Continuous core-sheath fiber forming was accomplished at 3600 to 4000°F. With feasibility established and the required high-temperature melt containment problem solved, the task remaining is to develop the concept to achieve higher core-to-sheath volume ratios consistent with continuous fiber formation. (auth)

724 (BMI–1809, Sect.C) COATED-PARTICLE FUEL MATERIALS. (Battelle Memorial Inst., Columbus, Ohio). 44p.

Characteristics of various Pu-base coated particle fuel materials were studied. The preparation of PuO_2 by Sol Gel, plasma torch, and mechanical shaping and sintering is discussed. In the preparation and characterization of pyrolytic-carbon (PyC) PuO_2 particles, coating equipment and procedures were improved and seven lots of coated particles were prepared for evaluation by metallography, microradiography, substrate analysis, whole-particle density, surface decontamination, α assaying for coating and surface contamination, and leaching for coating integrity. Comprehensive equipment and techniques for the thermochemical evaluation of the performance of Pu-bearing fuel particles were designed, assembled, and tested. Pyrolytic-carbon coated PuO_2 particles are relatively stable for short periods of time at 1500 to 1800°C. At higher temperatures particle failure results from chemical interaction of the coating and fuel. The coated particles are stable in repeated thermal cycling. In in-pile irradiation studies, the fission-gas release as a function of temperature was determined. The feasibility of coating fuel particles with graphite by precipitation from liquid-metal solutions is being studied. (F.S.)

725 (BMI–1809, Sect.E) UO_2–PuO_2 FUEL DEVELOPMENT. (Battelle Memorial Inst., Columbus, Ohio). 9p.

Fuel elements clad with Hastelloy X or stainless steel were

prepared using pellets fabricated from mechanically blended proportions of natural UO_2, fully enriched UO_2, and PuO_2, by cold pressing and sintering. Fuel material was characterized by metallographic, autoradiographic, gamma-scanning, and analytical chemistry techniques. Seven fuel elements containing 81 sintered pellets were sent to ORNL for irradiation and postirradiation examination. (F.S.)

726 (BNWL-SA-1388, pp 13.1-3) PLUTONIUM SUPPLY AGREEMENT. Starling, C. D. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

The procedure that the fuel fabricator follows for the procurement of Pu for the manufacture of the FFTF fuel is explained. (J.C.W.)

727 (BNWL-SA-1388, pp 14.1-10) PROCUREMENT PROCEDURES. Kenner, R. F. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

The procedures involved for a fuel fabricator of the FFTF fuels are explained. (J.C.W.)

728 (EUR-3497d) HERSTELLUNG UND EIGENSCHAFTEN VON Al-Al_2O_3-DISPERSIONSLEGIERUNGEN AUS DUENNEN FOLIEN. (Production and Properties of Al-Al_2O_3 Dispersion Strengthened Alloys from Thin Sheets). Kellerer, H.; Saur, G.; Borchers, H. (European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center). Mar. 14, 1967. 269p. (In German). Dep.

Only powder metallurgy methods are known for the production of the Al-Al_2O_3 dispersion strengthened alloys. Results of an investigation on the production of such an alloy by a technique which utilizes thin aluminium sheet are presented. Al sheets, 3 to 40 μm thick, were wound into spools and oxidized in either air, water, or vapor. Thereafter the spools were extruded into rods at about 600°C. The extrusion process caused the superficial oxide layers to break into small particles which were distributed through out the matrix. Metallography and mechanical property examination were used to determine the optimum conditions of fabrication of the alloy. The influence of oxide content and foil thickness on the mechanical properties was investigated. Utilizing foils of 3 μm and oxide layers of 0.2 μm maximum tensile strength of 32 kp/mm^2 at 20°C and 8 kp/mm^2 at 450°C were obtained. The results were in good agreement with the Orowan theory. Ductility depends on both volume fraction and interparticle spacing of the oxide. At 20 and 450°C different characterisitcs were obtained. It is shown that microcracks may be formed during the deformation of the Al-Al_2O_3 two-phase alloys and their influences on the strength and ductility are discussed. (auth)

729 (LA-DC-8803) FORMATION OF CARBIDE SURFACES ON TANTALUM AND TANTALUM-TUNGSTEN ALLOYS. Krikorian, N. H.; Wallace, T. C.; Krohn, R.; Bowman, M. G.; (Los Alamos Scientific Lab., N. Mex.). [1967]. Contract W-7405-eng-36. 20p. (CONF-670935-5). Dep. CFSTI.

From 3rd International Symposium on High Temperature Technology, Pacific Grove, Calif.

The formation of carbide layers on tantalum and tantalum-tungsten alloys based on layer growth measurements is discussed. Information is included on fundamental processes of carbon diffusion into tantalum at 1200 to 2800°C and the application of these fundamental findings. (F.S.)

730 (N-67-18983) STUDY OF GROWTH PARAMETERS FOR REFRACTORY CARBIDE SINGLE CRYSTALS. Quarterly Status Report, September 1-December 1, 1966. Bartlett, R. W. (Stanford Research Inst., Menlo Park, Calif.). Jan. 9, 1967. Contract NASr-49(19). 21p. (NASA-CR-82466). CFSTI.

Mixed solid solution boules have been grown with 40% hafnium carbide/60% tantalum carbide and 20% hafnium carbide/80% tantalum carbide starting powders. These boules were polycrystalline. There was little change in metal ratio for the 20/80 composition, but the hafnium content of the 40/60 composition reduced to 35% of the total metal content. For both compositions the carbon content was reduced to approximately 45 at. %. A few long hafnium carbide boules were grown with large single crystal sections, as determined by X-ray diffraction. These boules were grown at 5 to 10 cm/hr, and contain subgrain boundaries. Several modifications to equipment and operating procedures were made to improve the quality of tantalum carbide boules. Preliminary analyses indicate that the carbon content of tantalum carbide boules has not been increased over that obtained in 10% H_2/90% Ar gas mixture using previous operating practices. (auth) (STAR)

731 (N-67-19056) METAL CARBIDE-GRAPHITE COMPOSITES. Quarterly Report, November 1, 1966-January 31, 1967. Harada, Y. (IIT Research Inst., Chicago, Ill.). Contract NASr-65(09). 35p. (NASA-CR-82527; IITRI-G6003-2). CFSTI.

Fabrication of metal carbide-graphite composites by hot pressing at temperatures up to 3200°C, and the determination of physical and mechanical properties of these materials are examined. The relationship between electrical conductivity and flexural strength is evaluated. Mixing laws for multiphase systems were employed to analyze electrical and mechanical properties. Heat treatment studies were conducted to examine annealing effects on physical and mechanical properties. It was concluded that high strengths are directly related to soaking of composites at processing temperature and to the use of higher temperatures. A linear relationship appears between electrical conductivity and flexural strength for the NbC-C system in the compositional range, 20 to 88 volume per cent NbC. Heat treatment of high NbC content composites subsequent to hot pressing can result in significant improvement in strength due to sintering and diffusion bonding. The annealing process also produces dimensional changes due to relief of stresses which are imparted to billets on cooling after processing. (STAR)

732 (EURFNR-318) FABRICATION OF FUEL ELEMENTS FOR IRRADIATION IN THE EFFBR. PART I. FUEL FABRICATION. Dippel, Th.; Walther, K. H. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Radiochemie). Translated from report KFK-564. 10p. Dep. CFSTI.

Work Performed under United States-Euratom Fast Reactor Exchange Program.

Techniques for fabrication of the fuel for irradiation in the EFFBR are outlined. Preliminary testing is discussed. (J.C.W.)

733 (LA-tr-67-78) THE SCANDIUM-CARBON SYSTEM. Report No. 1. Rassaerts, H.; Novotny, H.; Vinck, G.; Benesovsky, F. Translated for Los Alamos Scientific Lab., N. Mex., from Monatsh. Chem., 98: 460-8(1967). 8p. Dep. CFSTI. JCL $1.10 fs, $0.80 mf.

Analytic data and results of x-ray diffraction studies of 8 samples of scandium carbides are reported. The specimens examined were prepared from powdered Sc and reactor-grade graphite and sintered at 1200 and 1350°C. The C content of the mixtures before heating varied from 10.5 to 39 at. %. X-ray analysis of the sintered carbides showed the existence of several phases including Sc_2C_3, Sc + $Sc_{2-3}C$, and $Sc_{2-3}C$, as well as a phase possibly of the Pu_2C_3 type. Assignment of indices was not successful but it was concluded that a series of peritectic reactions takes in the Sc-C system during sintering. (P.G.C.)

734 FUEL AND FERTILE MATERIALS. Reactor Mater., 10: 135-51(Fall 1967).

The progress made on reactor fuel and fertile materials is reported. Uranium and uranium alloys, plutonium, and thorium fuels research is summarized. Dispersion and coated-particle fuels are discussed. The properties and behavior of uranium oxides, carbides, nitrides, phosphides, sulfides, and thorium oxides are reported. Research on fuel and water reactions is reported. Irradiation effects in fuel materials is discussed. Included are 77 references. (J.C.W.)

735 PRODUCTION OF LITHIUM FLUORIDE CRYSTALS WITH SELECTED ISOTOPIC RATIOS OF LITHIUM. Thoma, R. E.; Ross, R. G.; Weaver, C. F. (Oak Ridge National Lab., Tenn.). J. Phys. Chem. Solids, 28: Suppl. 1, 147-9(1967).

Preparation of unusually pure single crystals of lithium fluoride weighing 300 g, and with selected ratios of lithium-7 to lithium-6, was reduced to a routine operation. The single crystals were grown from LiF precipitated from specially purified aqueous hydrogen fluoride and lithium hydroxide solutions and dehydrated at 900°C; the charge material was subsequently exposed only to purified helium until crystal growth and annealing was complete. Examination of the annealed crystals with interference filters under polarized light showed them to be free from strain, and their infrared absorption spectra showed the complete absence of hydroxyl ions. By continued refinements in the preparation and growth techniques, large crystals of LiF were prepared in which the concentration levels of manganese, the most likely contaminant, were found by neutron activation analysis to be lower than is currently detectable by this method (≤1.86 parts per billion). The principal application of these crystals has been in a study of the phonon scattering by boundaries and isotopes in LiF. (UK)

736 GROWTH AND PROPERTIES OF CeO_2 AND ThO_2 SINGLE CRYSTALS. Linares, Robert C. (Perkin-Elmer Corp., Norwalk, Conn.). J. Phys. Chem. Solids, 28: 1285-91(July 1967).

CeO_2 and ThO_2 were grown by the slow cooling and gradient flux techniques, using $2NaF \cdot B_2O_3$, $Li_2Mo_2O_7$, $NaBO_2$, $PbF_2 \cdot PbO \cdot 0.1\ B_2O_3$ and mixtures of these as solvents. Two growth morphologies were found to exist, which depended on flux composition. CeO_2 crystals up to 3 mm on an edge and ThO_2 crystals up to 10 mm on an edge were grown. The uv absorption spectra of

CeO_2 and ThO_2 were measured on pure and doped crystals. Several types of color centers (including permanent and bleachable) were found, which were promoted by specific impurities. Lead substitution from fluxes, and low level Ca^{2+} impurities, were common causes of color centers. (auth) (UK)

737 INFLUENCE OF PARTICLE SIZE DISTRIBUTION ON THE SINTERING OF CERAMIC POWDERS. Adwick, A. G.; Warmer, R. J. (United Kingdom Atomic Energy Authority, Dounreay, Scotland). pp 329-43 of Particle Size Analysis. London, Society for Analytical Chemistry, 1967.

From Conference on Particle Size Analysis, Loughborough, Eng., Sept. 14-16, 1966. See CONF-660954.

One of the factors that can affect the sintered density of a ceramic is the pressing behavior. This in turn is influenced by the particle size distribution. From an analysis of results on the packing of dense spheres and packing experiments on irregularly-shaped, coarse ceramic particles, a series of curves was derived. It is claimed that these curves can be used to relate the influence of particle size distribution on the packing efficiency, and ultimately on the sintering behavior of ceramic powders. The particle size distributions of $(UPu)O_2$ powders were measured with the optical microscope, and were correlated with subsequent pressing and sintering data by means of this analysis. Good agreement was found. This analysis could prove useful in the study of sintering mechanisms to ensure the non-interference of technological factors. It also illustrates the need for "effective" particle size distribution measurement rather than "true" distribution in the understanding of powder behavior. (auth) (UK)

738 RESEARCH ACTIVITY OF THE CNEN AT MOL IN THE FIELD OF Pu FUELS. Cogliati, Guido (CNEN, Mol, Belg.). Com. Naz. Energ. Nucl., Notiz., 13: No. 7, 37-46 (July 1967). (In Italian).

The studies made in the CNEN laboratories at Mol on the fabrication of Pu fuels are outlined. The hydrometallurgical methods used for the preparation of oxides of U and U-Pu are outlined. The sol-gel method developed for the preparation of UO_2 particles is shown schematically and compared with the ORNL method. The sol-gel method developed at the laboratory for preparation of $(U, Pu)O_2$ particles is given and discussed. (J.S.R.)

739 OBSERVATION OF MARKERS DURING THE OXIDATION OF COLUMBIUM. Roberson, J. A. (Wright-Patterson AFB, Ohio); Rapp, Robert A. Trans. Met. Soc. AIME, 239: 1327-31(Sept. 1967).

From the observation of Pt wire marker movement in the oxidation of Nb at high temperatures and low O_2 pressures, predominant cation diffusion in NbO_2 has been demonstrated. The Cu_2O molecule was used as an oxidizing species to study the nature of the porous scale and the location of the reduction site in the oxidation of Nb. The Nb_2O_5 scale contains microporosity and forms by alternate ionic diffusional growth and fracture. The oxidation of Nb at high temperatures and very low static pressure O_2 results in a relatively compact and protective Nb_2O_5 layer. (auth)

740 POLISHING ABILITY OF THE MICROPOWDERS OF REFRACTORY COMPOUNDS DEPENDING ON METHOD OF PRODUCTION. Artamonov, A. Ya.; Tutakov, O. V. (Inst. of Problem of Material Management, Kiev). Porosh. Met., Akad. Nauk Ukr. SSR, No. 9, 75-8(Sept. 1967). (In Russian).

Polishing characteristics of ZrC, TiC, TiB_2, and W_2B_5 were studied. Results show that micropowders synthesized by chemicothermal methods possessed better polishing ability than micropowders obtained by splitting hot-pressed briquettes of the same composition. (auth)

741 PRODUCTION OF CERAMIC GRADE THORIUM-URANIUM MIXED OXIDES. Cacciari, A.; Cogliati, G.; de Leone, R.; Ferrari, S. (to Comitato Nazionale per l'Energia Nucleare). Canadian Patent 757,567. Apr. 25, 1967. Priority date Dec. 5, 1961, Italy.

A process is described for the production of thorium-uranium mixed oxides from a thorium and uranyl nitrate solution containing less than 1.5 moles per litre of free nitric acid. The following steps are required: reduction of uranyl nitrate to uranium (IV) nitrate with gaseous hydrogen in the presence of a catalyst (finely divided platinum on a high surface inert carrier), cold precipitation of a mixed thorium-uranium (IV) oxalate with excess oxalic acid, firing of the filtered precipitate above 400°C. The uranium losses from the supernate are less than 5 mg/l. (F.S.A.)

742 IMPROVEMENTS IN OR RELATING TO SINTERING. Harrison, John David Lawrence; Roberts, William George (to United Kingdom Atomic Energy Authority). British Patent 1,088,724. Oct. 25, 1967. Filed July 29, 1964.

A method for sintering refractory nonfissile metal carbides or nitrides is described which consists of compacting in an inert gas atmosphere containing less than 20 ppM each of O and water vapor. The sintering is also carried out in an inert gas atmosphere containing less than 10 ppM of O and water vapor. (F.S.)

743 NUCLEAR FUEL AND BLANKET PARTICLES COATED WITH MIXTURE OF PYROLYZED CARBON AND A METAL CARBIDE. (to United States Atomic Energy Commission). British Patent 1,087,238. Oct. 18, 1967. Priority date Dec. 10, 1964, United States.

A method and the apparatus are described for use in producing improved pyrolyzed carbon coatings for nuclear fuel particles by simultaneously depositing pyrolyzed carbon and silicon under conditions such that the silicon is converted to silicon carbide. The improved coating has increased crushing strength and fission product retention. (F.S.)

744 METHOD OF AND APPARATUS FOR MELTING METALLIC OXIDES, MORE ESPECIALLY URANIUM DIOXIDE. Hoppe, Walker; Mueller, Norbert; Schmitten, Wilhelm i.d. (to EURATOM). British Patent 1,078,345. Aug. 9, 1967. Priority date Mar. 24, 1964, Germany.

Pressed compacts of urania, enclosed in a layer of powdered urania, are melted for fuel elements in a vertical water-cooled graphite crucible by an internal electric-resistivity method under a protective gas atmosphere. Other metallic oxides such as PuO_2 and UO_2-PuO_2 may also be melted by the process. (P.G.C.)

745 IMPROVEMENTS IN OR RELATING TO SINTERING REFRACTORY MATERIALS. Harrison, John David Lawrence; Roberts, William George (to United Kingdom Atomic Energy Authority). British Patent 1,079,042. Aug. 9, 1967. Filed July 29, 1964.

Dense bodies of PuC, Pu_2C_3, and ThC, for nuclear fuels, are produced by milling the powders in a shaker mill to <10μ, compacting at 20 tsi, using stearic acid in propyl alcohol as a die lubricant, and sintering under Ar or He at a temperature less than 1700°C. Densities obtained range from 93 to 97.5% of theoretical. (P.G.C.)

746 FABRICATION OF MATERIALS BY HIGH-ENERGY-RATE IMPACTION. Hague, James R.; Brite, Daniel W. (to U. S. Atomic Energy Commission). U. S. Patent 3,344,209. Sept. 26, 1967.

The fabrication of brittle materials by high-energy impaction is particularly applicable to beryllium oxide and to mixtures of beryllium and uranium oxides. The powdered material is enclosed in a graphite container which is surrounded on all sides by granular material within an outer can. The system is heated at 1500 to 1800°C and impacted at 14,000 to 20,000 kg/cm². (auth)

Properties Evaluations

Refer also to abstracts 55, 63, 652, 657, 674, 679, 724, and 731.

747 (AD-646925) THE MECHANICAL BEHAVIOR OF STRONTIUM ZIRCONATE. Final Report, October 15, 1965-October 14, 1966. Funk, J. E.; Nemeth, J.; Tinklepaugh, J. R. (State Univ. of New York, Alfred. Coll. of Ceramics). Contract NOw-66-0191. 60p. CFSTI.

Yielding perovskites such as $SrZrO_3$, $CaZrO_3$ and $BaTiO_3$ exhibit less notch sensitivity than was expected. A considerable amount of yield, without increase in stress, was observed in notched strontium zirconate samples having some porosity. It is speculated that free surface, increased by the flaws introduced by the notch and by the presence of some porosity, permitted uninhibited domain motion in grains exposed to that surface, It was observed that domain motion in perovskites under mechanical stress may be influenced by more than crystallographic shear angle. The defect structure in terms of the "A" cation and oxygen vacancies may affect both domain crystallography and the ease of domain motion. Iron was found to be a most useful addition to promote sintering in strontium zirconate. (TAB)

748 (BNWL-SA-1388, pp 11.1-26) CRITICALITY SAFETY CONSIDERATIONS IN THE FABRICATION OF 25 WT PERCENT PuO_2-UO_2 FFTF FUEL. Brown, C. L. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

A criticality safety program in a plutonium or enriched uranium facility is required. Four essentials are technical competence, administration policies to assure strict implementation of the limits, orientation of operating personnel in the use of the limits, and an audit to assure compliance with the limits. Critical parameters and safe limits are discussed. (J.C.W.)

749 (COO-1140-164) THERMODYNAMICS OF THE VANADIUM BORIDES. Spear, Karl E.; Schaefer, Harald; Gilles, Paul W. (Kansas Univ., Lawrence. Dept. of Chemistry).

Sept. 30, 1967. Contract AT(11-1)-1140. 24p. (CONF-670935-3). Dep. CFSTI.

From 3rd International Symposium on High Temperature Technology, Pacific Grove, Calif.

Results of experiments to develop thermodynamic data for vanadium borides are reported. Two types of experiments were conducted; a heterogeneous equilibrium investigation of the ternary system V–B–N, and a vaporization study of the V–B system including mass-spectrometric measurements on VB_2. Experimental apparatus and procedures are described and the heats of formation of the most-oxidized borides, carbides, and oxides of Group IV and Group V elements are presented graphically. An extensive bibliography is included. (P.G.C.)

750 (EUR-3566f) COMPORTEMENT DU SAP-ISML AU FLUAGE. (Creep Behavior of SAP-ISML). Bonnet, P.; Grin, M.; Mathey, G. (European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center). May 20, 1967. 102p. (In French). Dep.

The present state of the research on SAP creep is given. A review of the methods of preparing the material and of its mechanical properties is presented and the results obtained during 280,000 hours of creep are shown. Analyses are included of creep curves and creep rupture curves, and theories on the mechanism of SAP creep as a function of metallurgical factors such as dispersion, extrusion conditions, and heat treatment are discussed. A study of the SAP creep above the matrix melting-point, in relation to the hypothesis of Meyers and Sherby is presented. (tr-auth)

751 (LA-3653) CHARACTERIZATION OF COMMERCIAL CARBIDE POWDERS. Riley, R. E. (Los Alamos Scientific Lab., N. Mex.). Dec. 15, 1966. Contract W-7405-eng-36. 29p. Dep. CFSTI.

The problems associated with the development of a procurement specification for commercial carbide powders through powder characterization are reported. The morphological types of structures observed in commercial NbC, TaC, and ZrC powders are discussed. Also given are the results obtained for the various parameters determined to characterize powders. A technique for using these parameters in developing a procurement specification for a carbide powder to meet a particular requirement is proposed. (auth)

752 THE SURFACE SELF-DIFFUSION OF URANIUM DIOXIDE. Reynolds, G. L. (Central Electricity Generating Board, Berkeley, Eng.). J. Nucl. Mater., 24: 69-73(1967).

The decay of surface scratches on uranium dioxide at 1450 to 1700°C has been studied. Scratch widths were measured interferometrically after annealing in moist hydrogen. It has been shown that the process is controlled by surface diffusion. The surface diffusion coefficient is given by the equation $D_s = (5.6 \pm 2.4) \times 10^8 \exp[(-119{,}000 \pm 15{,}000)/(RT)]$. Mechanisms of surface-diffusion are discussed. (auth)

753 ENTHALPY AND HEAT CAPACITY OF NIOBIUM CARBIDE IN THE HOMOGENEITY DOMAIN OVER THE TEMPERATURE RANGE OF 1300 TO 2500°K. Turchanin, A. G.; Ordan'yan, S. S.; Fesenko, V. V. (Inst. of Problem of Material Management, Kiev). Porosh. Met., Akad. Nauk Ukr. SSR, No. 9, 23-7(Sept. 1967). (In Russian).

The values of enthalpy are determined for niobium carbide of four compositions in the homogeneity domain at 1300 to 2500°K. Equations of enthalpy and heat capacity dependence on the temperature were calculated over the investigated range of temperatures. (auth)

754 THERMOEMISSION OF ALLOYS OF TUNGSTEN–RARE EARTH OXIDES. Kondratov, I. Ya.; Podchernyaeva, I. A.; Fomenko, V. S. (Inst. of Problem of Material Management, Kiev). Porosh. Met., Akad. Nauk Ukr. SSR, No. 9, 79-83(Sept. 1967). (In Russian).

Thermoemission of W alloys with trivalent oxides of Ce, Pr, Nd, Sm, and Eu was investigated. Alloys were prepared by sintering in a vacuum. Tungsten yield φ decreased during alloying with rare earth oxides in the series Ce → Pr → Nd; the greatest decrease of φ (2.13 eV) occurred for the alloy with Sm_2O_3. (P.C.S.)

755 DETERMINATION OF THERMODYNAMIC ACTIVITY OF CARBON IN ALLOYED MOLYBDENUM CARBIDE. Alekseev, V. I.; Surovoi, Yu. N.; Shvartsman, L. A. (Central Scientific-Research Inst. of Ferrous Metallurgy, Moscow). Porosh. Met., Akad. Nauk Ukr. SSR, No. 9, 64-70(Sept. 1967). (In Russian).

Effects of carbon activity on alloying Mo_2C with Fe, Ni, and were studied at 600 to 900°C. Partial free energies, enthalpies, and entropies for various contents of C were determined. EMF data were obtained for Fe activity in the Fe_3Mo_3C type. It is shown that thermodynamic properties of C in Mo_2C carbide change under the effect of alloying even at concentrations less than 1 at. %. (auth)

Structure and Phase Studies

Refer also to abstract 733.

756 (AD-649351) RELATION OF MECHANICAL PROPERTIES TO THE STRUCTURE OF IONIC SOLIDS. Quarterly Technical Report No. 3, December 1, 1966–February 28, 1967. Vedam, K.; Vand, V. (Pennsylvania State Univ., University Park. Materials Research Lab.). Mar. 20, 1967. Contract DA-19-066-AMC-325(X). 15p. (AMRA-CR-66-07/3). CFSTI.

Measurements on the stress-strain relation in muscovite mica indicate that dislocations are mobile even at very low stress levels at room temperature. Irradiation with gamma-rays to 10 to the 7th power R did help to pin the dislocations but not completely. Etch pit studies indicate that the dislocations which lie and operate entirely in the (001) plane, dominate the mechanical properties of mica at low stress levels. Detailed x-ray crystal structure analysis of fluorophlogopite is in progress. (auth)

757 (COO-1441-4) THE DEFECT STRUCTURE OF NONSTOICHIOMETRIC $CeO_{2-\chi}$. Blumenthal, R. N.; Laubach, J. E. (Marquette Univ., Milwaukee, Wis. Coll. of Engineering). July 24, 1967. Contract AT(11-1)-1441. 19p. (CONF-670637-1). Dep. CFSTI.

From Symposium on Anisotropy in Single-Crystal Refractory Compounds, Dayton, Ohio.

The electrical conductivity of pressed and sintered specimens of $CeO_{2-\chi}$ was measured at 800 to 1500°C and at 1 to 10^{-17} atm of oxygen. Based on the excellent fit observed between the theoretically derived relation $\sigma^3 = (A\sigma + B)P_{O_2}^{-1/6}$ and the experimental conductivity data at 1000 to 1500°C, in the higher and intermediate oxygen pressure region, the nonstoichiometric defect structure of $CeO_{2-\chi}$ was interpreted in terms of a defect model involving quasi-free electrons and both singly and doubly ionized oxygen vacancies. The standard enthalpy of formation for selected defect reactions in $CeO_{2-\chi}$ was determined. At the lowest oxygen pressures at 1200 to 1500°C the electrical conductivity of $CeO_{2-\chi}$ appears to be relatively insensitive to oxygen pressure. In this region $CeO_{2-\chi}$ exhibits a large departure from stoichiometry and thus may behave as a degenerate semiconductor. (auth)

758 (LA-tr-67-92) STUDY OF THE REACTION OF POWDERED URANIUM AND CARBON: INFLUENCE OF THE PREFERENTIAL ORIENTATION OF GRAPHITE. Gregoire, Pierre. Translated by Rose Mary Boicourt (Los Alamos Scientific Lab., N. Mex.), from Comp. Rend., 254: 125-7(1962). 3p. Dep. CFSTI. JCL $1.10 fs, $0.80 mf.

The anisotropy of sintered UC, prepared from mixtures of U and graphite, was studied by radiocrystallographic and dilatometric methods. The reaction developed over a thermal cycle of heating (100°C/hr) and was completed at 1050°C. Variations in the sintered bars were characterized by an expansion of 10% in the parallel dimension and a contraction of 3% in the perpendicular dimension. It was concluded that anisotropy occurred as a result of reactions between the disoriented U and oriented C of anisotropic crystal structure. (P.G.C.)

759 THE Si–WSi_2–Si EPITAXIAL STRUCTURE. Hashimoto, Norikazu; Koga, Yasushi (Hitachi Ltd., Tokyo). J. Electrochem. Soc., 114: 1189-91(Nov. 1967).

Deposition of tungsten and the formation of its silicide layer by hydrogen reduction of the hexachloride on single-crystal silicon substrates are reported. The orientation relations between the silicide layer and the substrate were analyzed by electron diffraction and x-ray diffraction. The epitaxial growth of the silicon layer on the grown silicide layer was also investigated. (M.C.G.)

760 STUDIES ON $Pb(Zr-Ti)O_3$ CERAMICS WITH ADDITION OF Cr_2O_3. Uchida, Naoya; Ikeda, Takuro (Nippon Telegraph and Telephone Public Corp., Tokyo). Jap. J. Appl. Phys., 6: 1292-9 (Nov. 1967).

The solubility limit of Cr_2O_3 into $Pb(Zr-Ti)O_3$ was determined as about 2.2 mole % of $\frac{1}{2}Cr_2O_3$. In a region out of the limit, three phases were found; the perovskite-type solid solution, the baddeleyite-type ZrO_2, and 2 $PbO \cdot CrO_3$. By additions of Cr_2O_3 within the limit, the tetragonality or the difference of rhombohedral angle from $\pi/2$ was decreased, and the Curie point lowered. The temperature, bias, and aging characteristics of the piezoelectric ceramics with Cr additives were measured. The temperature coefficient of frequency constant decreased with Cr concentration. Addition of Cr_2O_3 decreased the dielectric and elastic anisotropies.

and increased the coercive field. The remanent electrostriction was notably large compared with that in the plain $Pb(Zr-Ti)O_3$ ceramics. The back-rotation of 90°-rotated domains with time tended to play a significant role in the ceramics with Cr additives, and this was considered as one of the reasons for the improved time stability in this system. (auth)

761 CALCINATION OF MICROPOROUS BeO POWDERS. Anderson, P. J.; Horlock, R. F. (Atomic Energy Research Establishment, Harwell, Eng.). Trans. Faraday Soc., 63: 2316-23 (Sept. 1967).

Two microporous BeO powders, which differed only in that the mean pore width was <6 Å in one and was ~6-20 Å in the other, were used to study the effect of molecular size pores upon the microstructural changes during calcination. As with macroporous oxides, the mean pore width increased with increasing calcination temperature and pores <6 Å width were eliminated by ~500°C. Since significant crystal growth in vacuo was not observed at such low temperatures, the initial presence of these very small pores had no significant effect upon crystal growth during calcination at high temperatures. The elimination of pores of width <6 Å was accompanied by a decrease in intra-aggregate pore volume (which was not observed on elimination of larger micropores) and this led to a lower temperature of aggregate densification for the oxide containing the smallest pores. In the presence of H_2O vapour the processes of pore and crystal growth occurred at significantly lower temperatures than in vacuo, but aggregate densification was not enhanced. (auth) (UK)

762 INVESTIGATION OF PHYSICO-TECHNICAL PROPERTIES OF ALLOYS OF W–BN SYSTEM. Artamonov, A. Ya.; Lapshov, Yu. K.; Kozachenko, M. V.; Yurchenko, D. Z.; Dudnik, E. M. (Inst. of Problem of Material Management, Kiev). Porosh. Met., Akad. Nauk Ukr. SSR, No. 9, 58-63(Sept. 1967). (In Russian).

Complex alloys of W–BN system were studied. The technology of producing the alloys with various boron nitride content is presented. Phase composition, microhardness, electric conductivity, and the thermal expansion coefficient were studied. (auth)

763 INVESTIGATION OF CERMET MICROSTRUCTURE IN THE SYSTEMS Mo–ZrO_2 AND W–ZrO_2. Popova, I. A.; Burenina, A. A.; Karasik, N. Ya.; Selivanova, I. T. Porosh. Met., Akad. Nauk Ukr. SSR, No. 9, 52-7(Sept. 1967). (In Russian).

The effects of Mo and W content and conditions of thermal treatment on the structure of ZrO_2 cermets were studied. Data are presented for specific compositions and mathematical expressions for the sizes of inclusions of metal phase as a function of metal content are given. It is shown that during isothermal timing alteration of the grain size is subjected to the exponential law. (auth)

Radiation Effects

Refer also to abstracts 724, 756, and 1779.

764 (AD–644889) TRANSIENT RADIATION DAMAGE IN SEMI-CONDUCTOR MATERIALS. Final Report No. 4, October 1, 1965–September 30, 1966. Corelli, John C.; Frederickson, A. Robb (Rensselaer Polytechnic Inst., Troy, N. Y.). Dec. 1966. Contract DA-28-043-AMC-01788(E). 89p. (ECOM-01788-F). CFSTI.

The transient behavior of the resistivity and Hall effect voltage in 1 to 100 ohm-cm n- and p-type silicon was studied both during and after exposing the sample to short bursts (0.01 to 4.5 microsec) of 48 MeV electrons. The buildup of excess electrons produced by ionization during the time the electron pulse is irradiating the sample appears to be dependent on the normal excess carrier decay rate. The injection levels induced by the bombarding electrons are high (delta n/n > 1/10) and in most cases the excess carrier lifetimes exhibit an increase with higher injection level. The temperature dependence of induced conductivity as a function of injection is consistent with that predicted by theory. The transient Hall voltage response of 100 ohm-cm p-type silicon for high injection levels can be approximately reproduced by calculation assuming mixed hole-electron conduction and equal hole and electron decay times by a single time dependent exponential. A simple model is given which describes fast annealing of 45 to 50 MeV electron-irradiated silicon. (auth)

765 (AECL–2701) REPLICA ELECTRON MICROSCOPY OF IRRADIATED URANIUM CARBIDE FUEL FROM PHASE 1 OF THE X-721 EXPERIMENT. Ross, A. M.; Rose, D. H. (Atomic Energy of Canada Ltd., Chalk River (Ontario)). Aug. 1967. 59p. Dep. CFSTI. CAN $1.50.

Details are given of an examination of fracture surfaces by replica electron microscopy applied to four irradiated uranium carbide specimens. These were obtained by ultrasonic drilling from known locations in two UC fuel pellets irradiated to average burn-ups of approximately 5600 and 7600 MWd/tonne U. Numerous pores and second-phase inclusions were evident on inspection of both intragranular and intergranular surfaces. It was concluded that most of the pores were fission gas bubbles and the inclusions uranium or a uranium/fission product phase precipitated in the slightly hypostoichiometric fuel pellets during irradiation. Estimates are made of the volume and gas content of the pores to assess their contributions to the slight macroscopic swelling and high fission gas retention observed for the fuel pellets. The size of the intragranular pores, and the swelling due to these, are compared with values calculated from published analyses of fission gas bubble growth. The formation of the grain boundary pores is examined in terms of fission gas movement by volume diffusion and bubble migration. (auth)

766 (BMI–1809, Sect.F) EFFECTS OF HIGH BURNUP ON UO_2–CeO_2 AND UO_2–ZrO_2 FUELS. (Battelle Memorial Inst., Columbus, Ohio). 8p.

Radiation stability was determined for 347 stainless steel clad solid-solution type ceramic fuels. The fuels were UO_2-ZrO_2 and UO_2-CeO_2. Two specimens experienced centerline melting. All specimens survived with little or no external evidence of damage. Diametral swelling was almost negligible. Segregation of fuel components occurred during irradiations. (F.S.)

767 (GEMP–557) TECHNIQUES IN NUCLEAR CERAMIC RESEARCH. White, J. F.; Fitzsimmons, E. S. (General Electric Co., Cincinnati, Ohio. Nuclear Materials and Propulsion Operation). Oct. 1967. Contract AT(40-1)-2847. 19p. (CONF-671019-1). Dep. CFSTI.

From Symposium on Research Techniques in Ceramics, Lexington, Ky.

The techniques peculiar to nuclear ceramic research are discussed with respect to the handling of radioactive and toxic materials. The effects of neutron radiation on BeO are highlighted to illustrate methods of determining property changes that can occur in a nuclear reactor environment; i.e., analyses of grain boundary separation, electron micrographs of the dislocation loops and He bubbles, the change in volume caused by irradiation, and the change in thermal diffusivity at different temperatures of irradiation. The high temperature properties of UO_2 as a function of stoichiometry are discussed in terms of the melting point, vapor pressure, and uranium-urania phase equilibrium to illustrate some of the current in-depths studies of ceramic materials of interest in nuclear energy. (auth)

768 (LA-DC–9059) THERMAL CONDUCTIVITY OF URANIUM–PLUTONIUM CARBIDE FUELS. Leary, J. A.; Johnson, K. W. R. (Los Alamos Scientific Lab., N. Mex.). [1967]. Contract W-7405-eng-36. 16p. (CONF-671005-4). Dep. CFSTI.

From Nuclear Metallurgy Conference, Phoenix, Ariz.

The thermal conductivity of uranium–plutonium carbides was reviewed. It was found that the thermal conductivity data for UC generally fall within ±20% at 200 to 2000°C. Over this range the conductivity is approximately constant at 0.05 cal/sec. cm°C. Replacement of uranium by plutonium in UC causes a significant decrease in thermal conductivity and diffusivity at 250 to 1000°C. Maximum thermal conductivity is observed in the near-stoichiometric composition range for UC and $U_{0.85}Pu_{0.15}C$. Nickel sintering aids lower the thermal conductivity and diffusivity of UC and (U, Pu)C. Apparently oxygen and nitrogen lowers the thermal conductivity of carbides. As fission products are generated in carbides fuels, it is unlikely that they will improve thermal conductivity. It seems more probable that the thermal conductivity will be reduced. There does not appear to be a satisfactory method for adjusting for the effects of porosity on thermal conductivity of carbides. More experimental work must be done on the thermal conductivity of fully characterized carbides in order to fully exploit this property in reactor applications. Future work on thermal conductivity should be related to measurement of the electrical resistivity on the same materials. (auth)

769 (N–67-25672) RADIATION EFFECTS ON SILICON. Quarterly Progress Report, October 1–December 31, 1966. Naber, J. B.; Horiye, H. (General Dynamics Corp., San Diego, Calif. General Atomic Div.). Jan. 10, 1967. Contract NAS7-289. 10p. (NASA-CR-83818; GACD-6249). CFSTI.

Transient and quiescent electrical conductivity in high-purity n-type silicon was studied by the microwave technique after irradiation by 30 MeV electrons at room temperature. The electron flux was controlled so that the introduction of the recombination center was detected. Pre-irradiation lifetime measurements were made using a flash X-ray machine, and the results are shown. The samples and microwave apparatus were moved to an

electron linear accelerator (Linac) where extra precautions were taken so that during Linac tuning the sample was not irradiated with high-energy electrons. The pre-irradiation lifetime of the high-resistivity silicon sample was analyzed using the Shockley–Read theory, and results are presented. The dc electrical conductivity transient measurements on silicon samples of carrier concentration about 10^{14} cm^{-3} are also briefly discussed. (auth)

770 (N–67–26321) THERMAL-NEUTRON-INDUCED DEFECTS IN CADMIUM TELLURIDE AND CADMIUM SULFIDE. Barnes, Charles E.; Kikuchi, Chihiro (Michigan Univ., Ann Arbor. Dept. of Nuclear Engineering). Mar. 1967. 147p. (NASA-CR–84064). CFSTI.

Experiments were conducted to clarify further the (n,γ) recoil-defect production in CdTe and CdS by measuring changes in Hall effect, electrical conductivity, and luminescence before and after successive thermal neutron irradiations. CdTe and CdS were chosen for study because of the large capture cross-section of Cd. In addition, radiative capture in Cd does not lead to transmutation doping since ^{114}Cd is a stable nucleus. The Hall effect of n and p-type CdTe and CdS was measured at 4 to 300°K after each irradiation. From this data information on the energy levels and carrier removal rates occurring in these materials was obtained. Luminescence measurements were carried out at 9°K at 4700 Å to 2.6 microns to ascertain the effect of thermal neutron-induced-defects on the emission bands in CdTe and CdS. A detailed examination of the thermal neutron induced recoil process reveals that only the first one or two gamma rays emitted contribute significantly to the recoil momentum. (auth)

771 (EURFNR–317) IRRADIATION BEHAVIOR OF MIXED URANIUM–PLUTONIUM CARBIDES, NITRIDES AND CARBON–NITRIDES. Mikailoff, H.; Mustelier, J. P.; Block, Jacqueline; Leclere, Jacques; Hayet, Lucien (Commissariat a l'Energie Atom que, Fontenay-Aux-Roses (France). Centre d'Etudes Nucleaires). Translated from report CEA-R–3223. 55p. Dep. CFSTI.

Work Performed under United States–Euratom Fast Reactor Exchange Program.

Two irradiation experiments were carried out on mixed uranium-plutonium carbides, nitrides and carbonitrides for fast reactor fuels. In the first experiment carried out with thermal neutrons, the fuel consisted of sintered pellets sheathed in a stainless steel can with a small gap filled with helium. There were three mixed monocarbide samples and the maximum linear power was 715 W/cm. After a burn-up slightly lower than 20,000 MWd/t, a swelling of the fuel which had ruptured the cans was observed. In the second experiment carried out in the BR-2 reactor with epithermal neutrons, the samples consisted of sintered pellets sodium bonded in a stainless steel tube. There were three samples containing different fuels and the linear power varied between 1130 and 1820 W/cm. Post-irradiation examination after a maximal burn-up of 1550 MWd/t showed that the behavior of the three fuel samples was satisfactory. (tr-auth)

772 EFFECT OF LOW TEMPERATURE NEUTRON IRRADIATION AND 20 TO 400°C ANNEALING ON THE DENSITY AND LATTICE PARAMETERS OF ALUMINUM OXIDE AND MAGNESIUM OXIDE. Kingery, W. D. (Massachusetts Inst. of Tech., Cambridge. Commissariat a l'Energie Atomique, Grenoble, France). Contract AT(30-1)-2574. J. Nucl. Mater., 24: 21-33(1967).

When irradiated at 77°K aluminum oxide and magnesium oxide show a lattice expansion and density decrease several times larger than when irradiated at pile ambient temperature; results are equivalent for single crystal and polycrystalline samples. For Al_2O_3 measured at 91°K, c-axis expansion is 2.69 times larger than a-axis expansion; after annealing at 400°C this ratio has decreased to 1.04. Lattice volume expansion and density decrease are equal for Al_2O_3, indicating the presence of the same numbers of interstitials and vacancies after irradiation and during annealing at temperatures up to 400°C. For MgO, lattice volume expansion and density decrease are equal up to 100°C, but differ at 250°C. This probably results from interstitial precipitation at dislocations. Isothermal annealing of density and lattice parameter follows a relation $P - P_0 = -k \ln t$, where P is a property change (Δc, Δa, $\Delta \rho$) and t is time. Observations of the temperature, time, and time-rate behavior of annealing are consistent with interstitials having a variety of detailed configurations combining with vacancies with an activation energy for the process distributed at 0.2 to 0.8 eV. (auth)

773 CLADDING AND STRUCTURAL MATERIALS. Reactor Mater., 10: 158-93(Fall 1967).

Corrosion by aqueous and gaseous media of zirconium, steel, stainless-steel, nickel-base alloys, and refractory metals is reported. Corrosion of refractory metals, vanadium alloys, and steels in sodium is summarized. The metal–water reactions for reactor cladding and structural materials are discussed. Summaries on the irradiation effects in nonfuel materials are tabulated. Metallurgical, mechanical, and diffusion studies continue for the cladding and structural materials. Studies of the properties of nonfueled refractories are reported and ceramic technology is investigated. A listing of 158 references is included. (J.C.W.)

774 X-RAY STUDIES OF THE RADIATION DAMAGE IN BERYLLIUM OXIDE DISPERSION FUELS. Walker, D. G.; Hickman, B. S. (AAEC Research Establishment, Sydney). J. Nucl. Mater., 24: 60-8(1967).

X-ray studies of BeO-based dispersion fuels are described which show that the matrix damage differs in two ways from that occurring in a fast neutron flux only. In regions traversed by recoiling fission fragments the anisotropic lattice growth is much less than that predicted from the fast neutron dose although the x-ray line broadening is increased. Also, beyond this recoil range the passage of the β particles arising from fission product decay causes the anisotropic lattice growth to be greater than that produced by the neutron dose alone. These observations are supported by the results of simulated experiments in which the effects of fission fragment and β particle bombardment in addition to neutron irradiation have been compared more directly with those of neutron irradiation alone. An additional observation from these experiments is that the fission fragment bombardment produces a large macroscopic growth in BeO. (auth)

775 THE IRRADIATION-INDUCED MACROSCOPIC GROWTH OF α–Al_2O_3 SINGLE CRYSTALS. Wilks, R. S.; Desport, J. A.; Smith, J. A. G. (Atomic Energy Research Establishment, Harwell, Eng.). J. Nucl. Mater., 24: 80-6(1967).

The fractional macroscopic growths produced along the a and c axes of α–Al_2O_3 single crystals by irradiation to doses in the range 10^{18} to 1.1×10^{21} nvt ≥ 1 MeV at 150 and 650°C have been measured. The growths, which increased with dose, were slightly anisotropic for irradiations at 150°C and highly anisotropic for irradiations at 650°C. From the determined growths, the irradiation conditions to avoid microcracking in polycrystalline alumina of 100 μm grain size have been predicted. Microcracking is not expected for doses up to 1.1×10^{21} nvt ≥ 1 MeV at 150°C or for doses below $\sim 2 \times 10^{20}$ nvt ≥ 1 MeV at 650°C, but is expected for doses above $\sim 5 \times 10^{20}$ nvt ≥ 1 MeV at 650°C. These predictions are consistent with the available experimental data on microcracking in irradiated alumina. (auth)

776 INSULATING MATERIALS FOR OPERATING IN A THERMAL NEUTRON FLUX. Kostyukov, N. S.; Dmitriev, V. I.; Stepanov, G. N.; Kharitonov, F. Ya.; Meikson, T.; Gorbatyi, L.; Golubev, V. P. (Scientific Research Inst. of High Temperatures, USSR). Teplofiz. Vys. Temp., 5: 361-6(1967). (In Russian).

The radiation resistance of several electric insulating materials has been investigated. It was assumed that the highest radiation resistance would be found in those insulating materials composed of elements which, under the effect of nuclear radiation, do not transform into new stable elements, have a minimum induced radioactivity and a minimum emanation of inert gases. The following materials were found to have these properties: corundum microlite (aluminum oxide), magnesia spinel, zirconium oxide, celsian, steatite, and wollastanite. (ATD)

777 EFFECT OF ATOMIC DISPLACEMENTS ON COLOR CENTER PRODUCTION IN MgO. Schall, Paul (Hughes Research Labs., Malibu, Calif.). J. Phys. Chem. Solids, 28: 1211-23(July 1967).

The optical absorption spectrum produced in MgO during exposures to 2×10^{16} α-particles/cm^2 was shown to consist of absorption bands with peaks at photon quantum energies of 4.25, 4.85, 4.9, 5.55 and 5.8 eV. The 4.9 eV band is attributed to F-centers, which are estimated to be present at a concentration of the order of 10^{19}/cm^3 after the highest α-particle exposure. The bands at 4.25, 4.85 and 5.55 eV are attributed to impurity centers. The concentrations of these centers are about 30-fold higher than when produced by irradiation with γ-rays to saturation coloration. The formation of color centers at impurity sites is apparently enhanced by the presence of lattice defects produced by atomic displacement processes. The continued growth of the 5.8 eV band at high radiation exposures suggests that this band is due to some type of defect center. (auth)

778 A COMPARISON OF THE BROMINATION AND IRRADIATION GROWTH OF GRAPHITE. Brocklehurst, J. E.; Martin, W. H. (United Kingdom Atomic Energy Authority, Warrington, Eng.). J. Nucl. Mater., 23: 341-6(1967).

The irradiation growth of graphite at 200°C is predicted from growth data obtained in bromination tests and irradiation induced crystal changes calculated in previous tests. These predictions are compared with the observed irradiation-induced dimensional changes at 200°C. The range of graphites selected, varying in degree of isotropy, are tabulated. (H.D.R.)

Plastics and Other Materials

Refer also to abstract 780.

779 (AERE-R-5552) EFFECT OF MOISTURE ON THE INHIBITORY ACTION OF PHOSPHORUS OXYCHLORIDE ON THE AIR OXIDATION OF GRAPHITE. Lewis, J. B.; Moul, A. N.; Murdoch, R. (Atomic Energy Research Establishment, Harwell (England)). July 1967. 19p. Dep. CFSTI. UK 3s. 0d.

The effect of adding $POCl_3$ to the air stream when nuclear graphite is oxidized in air was examined by following the change in temperature of the graphite specimen. When the air was dry, $POCl_3$ produced a rapid and marked diminution in the rate of oxidation, but when moisture was present the inhibition was much less and was slow to develop. In some experiments with moist air, addition of $POCl_3$ produced an acceleration of the rate. The presence of steel in the proximity of the graphite had no effect. (auth) (UK)

780 (CERN-67-25) RADIOACTIVITY INDUCED IN BUILDING MATERIALS. Barbier, M. (European Organization for Nuclear Research, Geneva (Switzerland)). Sept. 15, 1967. 34p. Dep.

In high-energy accelerator installations, two kinds of activating fluxes are found: the very high energy particles producing spallation, and the evaporation neutrons emitted by excited spallation products. These evaporation neutrons, subsequently moderated and thermalized, give rise to a neutron atmosphere which has an energy spectrum roughly similar to a fission spectrum or to a reactor spectrum measured behind some shielding. Computations of specific radiation fields in rad/hr/gram at 1 meter were made for both the spallation part (very high energy particles) and the evaporation part (thermal epithermal, fast neutron). The results vary widely from target to target for the evaporation neutrons, and lie between 10^{-11} and 10^{-20} rad/hr/gram at 1 meter. In contrast they are grouped together for nearly all materials around 10^{-14} rad/hr/gram at 1 meter in the spallation case, except for materials with mass numbers below 20 and for calcium, which are 10 times less active after one day. For building materials proper, it is interesting to compare experimental data on concrete and limestones, and to compare these with aluminium and iron, often used as structural or as shielding materials. For the experiments aluminium was used instead of iron, as the radiation levels in at least the first 15 hours are comparable both in the spallation and in the fast neutron region. The results are roughly as follows: Calcite Co_3Ca (either as marble or relatively pure rock) is three times less active than concrete or silica, and about ten times less than aluminium or iron. Carbon is usually still better than calcite. For low-level laboratories, the natural radioactivity of pure white marble is about the best that can be found in natural rocks. (auth)

781 (N-67-19129) EVALUATION OF CRYOGENIC INSULATION MATERIALS AND COMPOSITES FOR USE IN NUCLEAR RADIATION ENVIRONMENTS. Quarterly Progress Report, June 30-September 30, 1966. Kerlin, E. E. (General Dynamics/Fort Worth, Tex.). Oct. 3, 1966. Contract NAS8-18024. 84p. (NASA-CR-82450; FZK-319). CFSTI.

Efforts directed toward selecting candidate test materials, developing the test plan, and modifying existing test equipment are described. Two types of tests are planned for evaluating the radiation dose of 1×10^{11} ergs/gm(C) on materials: mechanical property evaluation of the individual components and combined systems, and functional evaluation of a composite system applied to a test dewar. (auth) (STAR)

782 (SCL-DR-67-110) ATTENUATION OF LONGITUDINAL, ULTRASONIC SOUND WAVES IN VARIOUS PLASTICS. Johnston, C. E. (Sandia Corp., Livermore, Calif.). Oct. 1967. Contract AT(29-1)-789. 12p. Dep. CFSTI.

The results of a study of the properties of a group of materials, especially as these properties pertained to the use of each material as an ultrasonic lens is reported. Primary emphasis was on determining signal loss by attenuation. (auth)

783 PHOTOELASTIC METHODS FOR SIMULATING THE THERMAL STRESSES. Visner, J. pp 190-202 of Sbornik Praci Zavodu Jaderne Elektrarny Oboroveho Podniku, Skoda, Plzen. Plzen, Czechoslovakia, Skoda Works, Department of Nuclear Power Stations, 1967. (In Czech).

Photoelastic methods for measuring thermal stresses are described. Thermal, mechanical, and optical properties of the modeling materials ChS Epoxy 110 and ChS Epoxy 12 are investigated on the base of model similarity laws and the suitability of these materials for the direct method is shown. Out of indirect methods the method of relieving frozen deformations was developed. This method was checked experimentally on plane and space models. The results of measurements are in agreement with the theoretical solution. (auth)

784 INVESTIGATION OF THE INFLUENCE OF IONIZING RADIATION UPON ORGANIC ELECTRIC INSULATION MATERIALS. Adamec, Vladimir (Research Inst. of Cables and Insulating Materials, Bratislava). Elektrotech. Obz., 56: 353-6 (June 1967). (In Czech.).

A survey of the trends in the investigation of the effect of ionizing radiation on organic insulating materials and of specific features of that radiation is presented. (JPRS)

785 RADIATION RESISTANT LUBRICANTS. DasGupta, S.; Slobodian, J. T. (to Atomic Energy of Canada Ltd.). Canadian Patent 756,597. Apr. 11, 1967.

Commercially available long-chain hydrocarbon lubricants having 12 to 26 carbon atoms were mixed with styrene to the extent of 10 to 50 wt %. Copolymerization was induced by subjecting the mixture to high-energy radiation not greater than 1×10^7 rads with periodic shaking. After such treatment, lubricating properties were maintained in service under radiation of 10^9 RADS with little or no deterioration. Five tables are given showing the test results obtained on ten commercial lubricants. (F.S.A.)

PHYSICS (GENERAL)

Astrophysics and Cosmology

Refer also to abstracts 941, 1002, 1060, 1168, 1231, 1373, 1494–1497, and 1710.

786 (AD-646372) BASIC SOLAR RESEARCH. Annual Report, October 1, 1965–October 1, 1966. Mohler, O. C. (Michigan Univ., Ann Arbor. Dept. of Astronomy). Contract Nonr-1224(19). 7p. CFSTI.

The staff of the McMath–Hulbert Observatory engaged in a number of studies concerned with solar activity, solar flares, solar–terrestrial relationships, solar spectroscopy, and applications of hydromagnetic theory to the Sun. (TAB)

787 (AD-646849) SOLAR FILAMENT STRUCTURE. Final Report, November 29, 1965–November 28, 1966. Ramsey, Harry E.; Smith, Sara F. (Lockheed-California Co., Burbank). Dec. 1966. Contract N00014-66-C-0059. 44p. (LR-20444). CFSTI.

A survey was made of the Lockheed solar patrol films in search of any parameters which could possibly be linked with the occurrence of flares. High resolution observations (≤1 sec of arc) show that some filaments increase in darkness and become more sharply defined within several hours to several days before the onset of a flare. However, if obtained only in the center of H-alpha, high resolution observations do not allow one to predict the onset times of flares any better than with observations of lower resolution. For flare prediction the utility of high resolution observations in the center of H-alpha is in enabling one to locate the positions of polarity change around which flares occur in an active center. Complex plage systems were defined as a combination of two adjacent plages or the growth of new plage in the midst of older plage. It is shown that such complex systems rarely fail to produce at least one major flare. The frequency of flaring in a complex system, however, does not appear to be statistically greater than for plages which are not complex according to the above definition. A few examples of preflare changes in fibrils were analyzed. These changes are thought to be related to short period, preflare changes in filaments because of their similarity in time of occurrence, position with respect to the ensuing flares, and general outward motion. (auth) (TAB)

788 (N-67-18634) STELLAR AND SOLAR FLARES. Schatzman, E. (National Aeronautics and Space Administration, Greenbelt, Md. Goddard Space Flight Center). Dec. 1966. 17p. (NASA-TM-X-55697; X-640-66-565). CFSTI.

Ideas concerning solar flares which have been previously presented by the author are developed. The insistence is put on the problem of energy transport from the energy supply to the region of the optical flare, on the storage of low-energy cosmic-ray particles in a magnetic bottle before the beginning of the optical flare, and on the mechanism which triggers both the optical flare and the production of high-energy cosmic rays. The relation between solar and stellar flares is considered. (auth) (STAR)

789 (NYO-844-72) NUCLIDE PRODUCTION BY COSMIC RAYS IN METEORITES AND ON THE MOON. Kohman, Truman P.; Bender, Michael L. (Carnegie-Mellon Univ., Pittsburgh, Pa. Dept. of Chemistry). Aug. 1967. Contract AT(30-1)-844. 77p. (CONF-670120-1). Dep. CFSTI.

From Symposium on High-Energy Nuclear Reactions in Astrophysics, Philadelphia, Pa.

A survey is given of the observation of products and rates of nuclear reactions in thick solid targets produced by cosmic radiation in space and by protons artificially accelerated to high energies. Methods used previously for calculating nuclide production rates in meteorites and on the lunar surface are reviewed. These methods include calculations based on particle fluxes and nuclear cross sections, Monte Carlo calculations of intranuclear and internuclear cascades, and the translation of thick-target bombardment data to spherical bodies in an isotropic flux. In order to systematize the radiochemical data on nuclear reaction rates in accelerator bombardments of thick targets by collimated proton beams, a model was developed based on the assumption that production is due to two particle components, designated "stiff" and "diffuse." For each component the lateral distribution is represented by a two-dimensional diffusion function, and the depth dependence is given by a linear buildup function. The resulting equation has 10 parameters, which are evaluated by a least-squares analysis. This analysis was applied to 25 sets of data from iron targets at 4 proton energies, 0.45, 1, 3, and 6 GeV and, in all cases, satisfactory fits were obtained. At each bombarding energy, six parameters were found to be similar for all products and were considered as "particle parameters." One is an artifact related to the finite width of the incident proton beam. Of the four "nuclide parameters," one was found to be the simple cross section at the incident proton energy for high-energy products, and somewhat larger for low-energy products. The other three were correlated with target-product mass-number difference. This enabled estimation of the parameters for other nuclides of interest, particularly ^{10}Be, ^{14}C, ^{26}Al, ^{36}Cl, and ^{53}Mn. A procedure was developed for calculating production rates of nuclides at various depths in spherical iron meteoroids of various sizes exposed to isotropic cosmic radiation, using the nine pertinent parameters at each of the four energies, and weighting each energy according to the integral galactic cosmic-ray-nucleon flux in corresponding intervals above 0.3 GeV per nucleon. Results are plotted for each of the five long-lived radionuclides mentioned. The calculated production rates were compared to observed specific activities in iron meteorites by correlation plots between pairs of nuclides: ^{10}Be-^{26}Al, ^{36}Cl-^{26}Al, and ^{53}Mn-^{26}Al. Order-of-magnitude agreement is excellent, though there are many specific cases of disagreement. Several reasons for disagreement, including deficiencies in both the experimental data and the calculations, are discussed. Suggestions for improving and extending both are made. Applicability of this approach to thick-silicate-target bombardments, stone-meteorite data, and the lunar surface is mentioned. Experimental and theoretical work needed to improve our knowledge of cosmogenic nuclear reaction rates in solid objects is discussed. (auth)

790 (TT-65-50400/4-6, pp 5-15) INVESTIGATION OF THE SHORT-WAVE END OF THE SOLAR SPECTRUM BY MEANS OF ARTIFICIAL SATELITES AND ROCKETS. Mandel'shtam, C. L.; Vasil'ev, B. N.; Voron'ko, Iu. K.; Tindo, I. P.; Shurygin, A. N.; Fetisov, E. N. Translated from Glas. Hem. Drus., Beograd, 30: 141-51(1965).

The results of investigations of the short-wave end of the solar spectrum carried out in the last few years at the Lebedev Institute of Physics are presented briefly. This short-wave radiation is due to the corona and extends in wavelength down to a few angstroms. In the experiments described the radiation receivers were photon counters with windows of beryllium foil and thin mica sheet, cutting off the longwave end of the spectrum at about 10 Å. (W.D.M.)

791 FREQUENCY SPLITTING OF SOLAR RADIO BURSTS. Ellis, G. R. A.; McCulloch, P. M. (Univ. of Tasmania, Hobart, Australia). Aust. J. Phys., 20: 583-94(Oct. 1967).

Solar radio bursts showing frequency splitting have been observed regularly below 60 MHz. The bursts have a duration of 1 to 2 sec and a frequency interval between their elements of 0.1 to 1.0 MHz. Their wave frequency generally decreases with time at about 0.1 MHz sec. The burst may occur either in isolation, in chains associated with type-III bursts, or in large numbers during noise storms. Triple splitting is observed in about 10% of the bursts. The properties of the bursts are not inconsistent with those expected from magnetic splitting of the radiation. (auth)

792 A SURVEY OF THE SOUTHERN SKY AT 85 MHz. Yates, K. W.; Wielebinski, R.; Landecker, T. L. (Univ. of Sydney). Aust. J. Phys., 20: 595-607(Oct. 1967).

A survey at 85 MHz is presented of the sky south of declination $\delta = -20°$, and of the northern galactic spur region to $\delta = +20°$. The survey was made with the 210 ft. telescope at Parkes, New South Wales. At this frequency the observed beam width was 3.5° by 3.8° to half-power points. The radiation characteristics of the survey aerial and of scaled aerial models were studied to enable corrections to be made for radiation received by the aerial from regions outside the main beam. Absolute beam temperatures derived from the observed aerial temperatures had an r.m.s. accuracy of better than 7%. (auth)

793 OPTICAL POSITIONS OF BRIGHT GALAXIES SOUTH OF +20° DECLINATION. Glanfield, J. R.; Cameron, M. J. (Univ. of Sydney). Aust. J. Phys., 20: 613-15(Oct. 1967).

To study the radio emission of bright galaxies, it has been found that their coordinates are needed with an accuracy considerably greater than that available from the NGC and IC catalogs. In the course of a series of observations with the Mills Cross telescope, it was necessary to remeasure the optical positions of the 139 galaxies on the program. The new positions are accurate to better than 0.2 min of arc. (W.D.M.)

794 ON THE NATURE OF THE "STANDARD" ABSORPTION SPECTRUM OF THE QUASI-STELLAR OBJECTS. Shklovskii, Ya. (Shernberg Astronomy Inst., Moscow). Astrophys. J., 150: L1-3(Oct. 1967).

Burbidge (1967) and Burbidge and Burbidge (1967) have argued that the presence of a standard spectrum in the quasars is a decisive proof in favor of the local hypothesis according to which the large red shifts observed are caused, not by cosmological effects, but by inherent properties of the quasars. A brief discussion is presented to the effect that it is the presence of the standard spectrum that is the most important argument in favor of the cosmological nature of the red shifts in the spectra of the quasars. (W.D.M.)

795 OPTICAL VARIATIONS IN THE RADIO GALAXY 3C 371. Oke, J. B. (Carnegie Inst. of Washington, D. C. California Inst. of Tech., Pasadena). Astrophys. J., 150: L5-8 (Oct. 1967).

The nucleus of the N-type radio galaxy 3C 371 has been observed to change in brightness by over 1 mag during the last 2 years and by 0.10 to 0.15 mag over intervals of a few days. Its luminosity is one-tenth that of 3C 48, assuming 3C 48 to be at the cosmological distance. The rapid variability of quasi-stellar sources can no longer be used as an argument against their cosmological nature. (auth)

796 ADDITIONAL DATA ON THE OPTICAL VARIATIONS IN 3C 371 AND OTHER PROPERTIES OF N-TYPE GALAXIES. Sandage, Allan (Carnegie Inst. of Washington, D. C. California Inst. of Tech., Pasadena). Astrophys. J., 150: L9-12(Oct. 1967).

Optical variation in the N-type galaxy 3C 371 has been found in the course of a UBV monitor program, confirming the independent prior discovery by Oke. N-type galaxies obey the Hubble expansion law defined by the radio galaxies studied so far. They are at cosmological distances. The optical variation of 3C 371 by at least 0.5 mag provides the single counter-example needed to show that rapid variation of optical flux of any object does not require that the object be local. (auth)

797 THE FLUX OF THE RADIO SOURCE W49 AT 7.83 GHz. Burke, B. F.; Wilson, T. L. (Massachusetts Inst. of Tech., Cambridge). Contract DA-36-039-AMC-03200(E). Astrophys. J., 150: L13-14(Oct. 1967).

It was found that the flux of the thermal source in W49 is 64.5×10^{-26} W m^{-2} $(c/s)^{-1}$ and the flux of the nonthermal source is 18.9×10^{-26} W m^{-2} $(c/s)^{-1}$ (auth)

798 POLARIZATION OF CYGNUS A AT 1.95 CM WAVELENGTH. Schraml, J.; Turlo, Z. (National Radio Astonomy Observatory, Green Bank, W. Va.). Astrophys. J., 150: L15-22(Oct. 1967).

Since Soboleva's model predicted a rapid increase of the degree of polarization of the individual components of Cyg A at shorter wavelengths (in excess of 20% at 2 cm), it was decided to check this prediction by direct measurements with an instrument with high angular resolution. (W.D.M.)

799 PHOTOMETRIC MONITORING OF SCO XR-1. Hiltner, W. A.; Mook, Delo E. (Univ. of Chicago. Cerro Tololo Inter-American Observatory, Chicago). Astrophys. J., 150: L23(Oct. 1967).

An abbreviated report is presented on a program at the Cerro Tololo Inter-American Observatory in which Sco XR-1 was photometrically monitored in order to evaluate the characteristics of the reported rapid variations. There was no evidence for any period from 2 min to 1 hour. (W.D.M.)

800 UBV PHOTOMETRY OF SCO XR-1. Mook, Delo E. (Univ. of Chicago. Cerro Tololo Inter-American Observatory, Chicago). Astrophys. J., 150: L25-30(Oct. 1967).

UBV photometry of the object identified as Sco XR-1 was carried out on the 42 consecutive nights between February 6 and March 19, 1967. No periodic variation was detected. The amplitude of the brightness variations appears to increase with decreasing effective wavelength. (auth)

801 JETS AND FILAMENTS IN HARO'S VIOLET GALAXIES. Kiang, T. (Dunsink Observatory, Dublin). Astrophys. J., 150: L31-2(Oct. 1967).

While measuring the sizes of some galaxies on Palomar Atlas prints, a pronounced jet was found on an object which turned out to be one of Haro's violet galaxies (No. 22). On examination of the rest of Haro's galaxies, well over one third of the galaxies showed a jet, or jets, or a system of filaments. (W.D.M.)

802 INTERPRETATION OF THE HELIUM WEAKNESS IN HALO STARS. Sargent, Wallace L. W. (Carnegie Inst. of Washington, D. C. California Inst. of Tech., Pasadena); Searle, Leonard. Astrophys. J., 150: L33-7(Oct. 1967).

A high-dispersion spectrogram of the field horizontal-branch B star, Feige 86, is described. This spectrum resembles that of the abnormal, Population-I, B star 3 Centauri A. In consequence, the weak helium lines found in the spectrum of Feige 86 and of similar stars in globular clusters can no longer be taken as indicating a low helium abundance in the material from which they formed. (auth)

803 INFRARED EMISSION FROM CIRCUMSTELLAR SHELLS. Johnson, H. L. (Univ. of Arizona, Tucson). Astrophys. J., 150: L39-43(Oct. 1967).

The relationship between spectral type and intrinsic K−L color index is investigated for early-type stars. Most early-type stars, both dwarfs and supergiants, have the colors expected from black bodies of the stellar temperatures. Several known shell stars, however, are considerably redder in K−L, and this K−L excess is interpreted as due to infrared emission from the circumstellar shells. Part, but not all, of the large infrared excesses observed for the early-type stars in the Orion region might be explainable as emission from circumstellar shells, but the remainder must still be explained by a peculiar extinction law. (auth)

804 ON THE DETERMINATION OF THE ELECTRON TEMPERATURES OF H II REGIONS FROM THE RADIO-FREQUENCY RECOMBINATION LINES OF HYDROGEN. Dyson, J. E. (Univ. of Wisconsin, Madison). Astrophys. J., 150: L45-50(Oct. 1967).

Factors b_n were calculated for the high ($n > 40$) levels of hydrogen in gaseous nebulae. Electron temperatures were derived from published recombination line data allowing for the possibility of maser action. There is no systematic difference between these temperatures and those derived from observations at optical wavelengths. (auth)

805 INTERSTELLAR HYDROGEN DENSITY. Fischel, David; Stecher, Theodore P. (Goddard Space Flight Center, Greenbelt, Md.). Astrophys. J., 150: L51-2(Oct. 1967).

The interstellar neutral hydrogen column density derived from the measurement of Ly-α and 21-cm observations differ by a factor of 10 in the Orion direction. It is suggested that the discrepancy may be resolved when the interpretation of the radio observations includes the overpopulation of the upper state due to excitation by blueshifted Ly-α and the resulting maser action. (auth)

806 IMPROVED BOUNDARY CONDITIONS FOR THE FEAUTRIER METHOD. Auer, Lawrence (Joint Inst. for Lab. Astrophysics, Boulder, Colo.). Astrophys. J., 150: L53-5(Oct. 1967).

One of the chief disadvantages of the Feautrier method is that it gives results at the boundaries which have much lower accuracy than those within the material. A simple improvement to the boundary conditions is suggested which can increase accuracy by a factor of up to 40 with practically no increase in computing time. (W.D.M.)

807 LINE FORMATION WITH NON-COHERENT ELECTRON SCATTERING IN O AND B STARS. Hummer, D. G.; Mihalas, D. (Univ. of Colorado, Boulder). Astrophys. J., 150: L57-9(Oct. 1967).

Electron scattering plays an important part in the formation of spectral lines in O and B stars. Recently Underhill (1964), de Groot and Underhill (1964), and Underhill and de Groot (1964) have calculated profiles for a number of lines using Underhill's model atmosphere results for these stars. In order to obtain reasonable agreement with the observed profiles, they found it necessary to introduce substantial microturbulence in the model. A spectroscopic diagnosis based on a static model which predicts supersonic motions is, to say the least, not self-consistent and perhaps is quite unreliable. Before postulating strong turbulence it seems prudent to examine further the mechanism of line formation to determine whether the observed widths can by explained by other means. (W.D.M.)

808 COSMOLOGY, BLACK-BODY RADIATION, AND THE DIFFUSE X-RAY BACKGROUND. Brecher, K.; Morrison, P. (Massachusetts Inst. of Tech., Cambridge). Astrophys. J., 150: L61-4(Oct. 1967).

Previous calculations (Felten and Morrison 1966) are extended to include the various cosmological effects and examine how far back one must look to see Compton recoil photons in numbers equal to those observed. If one can satisfy experimental x-ray observations, fitting both shape and intensity of observed spectrum, without invoking an epoch of the Universe so ancient that the physical conditions of galaxies cannot be assumed to be broadly

the same as those seen locally, the view that x rays arise from inverse Compton scattering receives strong support and may serve as an independent test of the 3°K black-body radiation. (W.D.M.)

809 FISSIOGENIC XENON IN THE RENAZZO AND MURRAY METEORITES. Funk, H.; Podosek, F.; Rowe, M. W. (Univ. of California, Berkeley). Geochim. Cosmochim. Acta, 31: 1721-32(Oct. 1967).

Xenon data from a stepwise heating of the Murray and Renazzo carbonaceous chondrites by Reynolds and co-workers are reinterpreted, and confirm the exceptionally large amounts of fission-produced xenon postulated. The interpretation supports the existence of three xenon components in Murray and Renazzo, probably best explained as (i) a primitive trapped component, (ii) a fission component, and (iii) an atmospheric-like component. The excessive amounts of fissiogenic xenon cannot be accounted for by atmospheric contamination, cosmic-ray xenon, or diffusion effects. (auth) (UK)

810 THE SPECTRUM OF P CYGNI IN 1964. Luud, L. S. (Inst. of Physics and Astronomy, Tallin, USSR). Sov. Astron. AJ (Engl. Transl.), 11: 211-19(Sept.-Oct. 1967).

Translated from Astron. Zh., 44: 267-77(Mar.-Apr. 1967).

It is established by the rough-analysis method that the ionization temperature in the envelope of P Cyg is 19,400°K, and that the star's Zanstra temperature is 25,800°K. Except for oxygen and nitrogen, the chemical composition of the envelope is normal. A comparison between the equivalent widths derived here and Beal's values shows the widths to be variable. (auth)

811 ON THE NUCLEOSYNTHESIS OF LITHIUM, BERYLLIUM, AND BORON. Bernas, R. (Faculte des Sciences, Orsay, France. Centre National de la Recherche Scientifique, Orsay, France); Gradsztajn, E.; Reeves, H.; Schatzman, E. Ann. Phys. (N.Y.), 44: 426-78(1967).

The nuclear physics of the spallation reactions leading to the formation of lithium, beryllium, and boron form proton bombardment on light nuclei is reviewed. A large amount of experimental data is gathered, including in particular several measurements made at Orsay with the 150-MeV synchrocyclotron. A simple rule is devised which classifies quite neatly the cross sections in term of their isotopic spin parameters. This rule can be used to predict the results of unmeasured reactions. For ^{12}C and ^{16}O target nuclei, more accurate determinations are made with the help of calculations based on statistical models. All this information is used to determine the formation ratios of the Li, Be, and B isotopes in C, N, O, and Ne, first by protons of fixed energies, second by cosmic-ray protons with an extended energy spectrum. (auth)

812 OBSERVATIONS OF POLARIZATION OF LUNAR RADIO EMISSION AT 0.8 cm WITH HIGH RESOLUTION. Losovskii, B. Ya. (Lebedev Inst. of Physics, Moscow). Sov. Astron. AJ (Engl. Transl.), 11: 329-31(Sept.-Oct. 1967).

Translated from Astron. Zh., 44: 416-18(Mar.-Apr. 1967).

The radial dependence of relative plane polarization of lunar radio emission was measured at 0.8 cm using the 22-m radio telescope of the Lebedev Physics Institute with a directional diagram of 2'. The maximum polarization value was $(4 \pm 1)\%$. Comparison with theoretical models computed for the case of a smooth lunar surface and also taking into account large-scale roughnesses made it possible to determine the dielectric constant $\epsilon = 1.5 \pm 0.2$ and the effective scattering angle ≈30°. Allowance for diffuse scattering on small roughnesses results in an increase of ϵ to 2.3 ± 0.5, which agrees with radar data. This is evidence of the important role of diffuse scattering for waves shorter than 1 cm. (auth)

813 SOME PROBLEMS OF MASS TRANSFER IN CLOSE BINARY SYSTEMS. Piotrowski, S. L. (Univ. of Warsaw). Sov. Astron. AJ (Engl. Transl.), 11: 191-204(Sept.-Oct. 1967).

Translated from Astron. Zh., 44: 241-59(Mar.-Apr. 1967).

A review is given of the problem of mass transfer in close binary systems, insofar as the mechanics of mass points is applicable. Most of the results have been published previously, although some aspects of this presentation may be new. The topics discussed include: variations in the orbital elements of a binary system due to isotropic mass loss; variations induced by the release or arrival of an individual mass particle; and variations caused by the attraction of a particle traveling in the orbit plane upon the component stars. A description is given of the mass-ejection mechanism involving a component that has filled its Roche limit but whose axial rotation is not synchronized with its orbital motion, and the types of gas streams that should develop in this situation are discussed. Some results of computations for orbital period and eccentricity variations are presented for the case where mass flows out near the Lagrangian point L_1. The principal limitations of the point-mechanical treatment are outlined briefly. (auth)

814 PHOTOELECTRIC AND SPECTROGRAPHIC OBSERVATIONS OF THE FLARES OF UV CETI IN 1965. Gershberg, R. E.; Chugainov, P. F. (Crimean Astrophysical Observatory, Moscow). Sov. Astron. AJ (Engl. Transl.), 11: 205-10(Sept.-Oct. 1967).

Translated from Astron. Zh., 44: 260-6(Mar.-Apr. 1967).

Preliminary results are reported for simultaneous photoelectric and spectrographic observations of the flare star UV Cet. A method described previously was used. UV Cet spectra were obtained in three regions (near H_γ, H_δ, and H_α) with 1 to 2^m times resolution. During 36 h of photoelectric observations seven flares of UV Cet were recorded; spectrographic material was obtained for six of them. Light curves of the flares are presented, their luminosities are computed, and all the spectrograms are described. Quantitative parameters are given for the spectrum, widths and equivalent widths of the hydrogen and helium emission lines and the intensity jumps at the heads of the TiO molecular bands, for various phases of flare development and for the quiescent state of UV Cet. (auth)

815 A DETAILED ANALYSIS OF SPECTRAL LINES OF WOLF–RAYET TYPE STARS. Lyu Van, Lyong Sov. Astron. AJ (Engl. Transl.), 11: 224-32(Sept.-Oct. 1967).

Translated from Astron. Zh., 44: 283-94(Mar.-Apr. 1967).

A method for the detailed analysis of spectral lines of W–R type stars is proposed. The method is based on the specificity of geometric boundary conditions of line formation in the stellar envelope and on a widely accepted envelope model. Expressions for the velocity distribution in the envelope, limb-darkening function, dimensions of the envelope are derived and a method for estimating the population ratios h_k/h_l in the envelope is proposed. A preliminary application of the method to four lines in the case of four W–R stars has provided interesting results concerning the physical properties of the stars and their envelopes. (auth)

816 ORIGIN OF GALAXIES IN AN EXPANDING UNIVERSE. Doroshkevich, A. G.; Zel'dovich, Ya. B.; Novikov, I. D. Sov. Astron. AJ (Engl. Transl.), 11: 233-9(Sept.-Oct. 1967).

Translated from Astron. Zh., 44: 295-303(Mar.-Apr. 1967).

In the hot cosmological model density fluctuations develop and the genesis of protostars, quasars, galactic clusters, and individual galaxies follows in sequence. The density fluctuations $\delta\rho/\rho$ are shown to reach an appreciable value when $\rho \sim 10^{-28}$ to 10^{-27} g/cm^3. The first generation of metagalactic objects, protostars which develop from the density fluctuations, have a mass $\sim 10^8 M_\odot$ and heat the surrounding gas. About 10^{-4} of the total metagalactic mass passes through the protostars. The second generation of objects, of mass range $M \sim 10^9$ to $10^{10} M_\odot$, arises from inhomogeneities created by the protostars. These second-generation objects produce further inhomogeneities of mass range 10^{13} to $10^{14} M_\odot$, which separate into clouds that in turn fragment into galactic clusters and individual galaxies as a result of thermal instability. The entire process from the birth of protostars to the separation of galactic clusters takes place over a short period of time, during which the mean density changes by approximately one order of magnitude. The stages in this process are discussed. (auth)

817 POSSIBLE MASER EFFECT IN CLOUDS OF INTERSTELLAR HYDROGEN IN THE GALACTIC CORONA. Shklovskii, I. S. (Shternberg State Astronomical Inst., USSR). Sov. Astron. AJ (Engl. Transl.), 11: 240-3(Sept.-Oct. 1967).

Translated from Astron. Zh., 44: 304-8(Mar.-Apr. 1967).

It is suggested that the 21-cm emission from clouds of interstellar hydrogen in the galactic corona is due to a maser effect. The red wing of the Lyman-α line provides pumping as the cloud moves toward the source of ultraviolet quanta. It is shown that population inversion of the hyperfine-structure sublevels of hydrogen atoms can reach $\sim 10\%$, indicating that the maser effect is extremely important. As estimated according to the new interpretation, the mass of the gas in the coronal clouds is smaller by a factor of hundreds than has previously been assumed, so that most of the difficulties encountered by the earlier theory of these clouds are eliminated. The fact that the clouds' radial velocities are primarily negative is explained by the operating conditions of the natural cosmic maser. (auth)

818 SPECTRA AND THE FREQUENCY DEPENDENCE OF ANGULAR DIMENSIONS OF SOME MODELS OF DISCRETE SOURCES OF COSMIC RADIO EMISSION. Braude, S. Ya. (Ins. of Radiophysics and Electronics, Kiev). Sov. Astron. AJ (Engl. Transl.), 11: 244-50(Sept.-Oct. 1967).

Translated from Astron. Zh., 44: 309-19(Mar.-Apr. 1967).

A spherically symmetric discrete source in which the magnetic field, the concentration of relativistic electrons, and the density of ionized hydrogen (if it is present) are functions of radial posi-

tion is considered. General formulas are derived for the radiation flux density and the frequency dependence of the angular dimensions in the case of an arbitrary spherically symmetric distribution of emission and absorption throughout the source. A detailed calculation of these quantities for three specific models with uniformly decreasing or increasing (to a limiting value) distributions is performed. The asymptotic forms of the low- and high-frequency spectra are determined and the use of these and analogous characteristics as criteria for the presence of reabsorption or absorption in ionized H II regions is discussed. (auth)

819 AN EXPLANATION OF THE ANOMALOUS HELIUM ABUNDANCE IN THE STAR 3 CEN A. Novikov, I. D.; Syunyaev, R. A. Sov. Astron. AJ (Engl. Transl.), 11: 252-7(Sept.-Oct. 1967).

Translated from Astron. Zh., 44: 320-7(Mar.-Apr. 1967).

The helium anomalies in 3 Cen A are considered. The difficulties of the existing attempts to explain these anomalies are discussed. A hypothesis is proposed to explain the anomalously large ratio $He^3/He^4 \approx 5$ to 10 with simultaneously small content of d by processes occurring only on the stellar surface. The decrease of the general helium content on the surface [in 3 Cen A this content is $(He^3 + He^4)/H \approx 0.02$] is the result either of the decay of free neutrons in reactions of helium-breaking by nonthermal particles or of the many times repeated process of tritium decay and its synthesis by means of the capture of free neutrons by He^3. It has been shown that the 3 Cen A and B system is not a physical pair. (auth)

820 POSSIBLE MECHANISMS FOR GENERATING HARD X RAYS IN SOLAR FLARES. Korchak, A. A. Sov. Astron. AJ (Engl. Transl.), 11: 258-63(Sept.-Oct. 1967).

Translated from Astron. Zh., 44: 328-35(Mar.-Apr. 1967).

A comparison is made between the spectral radiant power of bremsstrahlung and synchrotron and inverse Compton radiation. The region of the x-ray spectrum in which each mechanism will predominate is determined, depending on the physical conditions in the radiating region and the behavior of the accelerated-electron energy spectrum. If the electrons have a power spectrum extending with constant slope into the region $E_k \leq 10^6$ eV, bremsstrahlung will predominate throughout the x-ray region, $E_\gamma \geq 1$ keV. (auth)

821 THEORY OF STRONG SHOCK PROPAGATION IN AN INHOMOGENEOUS COSMIC MEDIUM. Kaplan, S. A. (Gorky State Univ., USSR). Sov. Astron. AJ (Engl. Transl.), 11: 302-4 (Sept.-Oct. 1967).

Translated from Astron. Zh., 44: 384-6(Mar.-Apr. 1967).

The approximation formula $V = \text{const} \times (NS)^{-1/4}$ can be used to determine the velocity of a strong shock wave traveling through an inhomogeneous medium, where V and S are the shock velocity and divergence, and N is the gas concentration. (auth)

822 CHROMOSPHERIC HEATING ABOVE A SUNSPOT. Marik, M. (Eotvos Univ., Budapest. Shternberg Astronomical Inst., Moscow). Sov. Astron. AJ (Engl. Transl.), 11: 264-8 (Sept.-Oct. 1967).

Translated from Astron. Zh., 44: 336-41(Mar.-Apr. 1967).

Calculations were previously made for the flux of magnetohydrodynamic waves emerging from sunspots. It is here shown that, as for an active chromosphere, the heating of the chromosphere above a spot is produced primarily by retarded magnetoacoustic waves which are transformed into weak shock waves. The results of the calculations are given. In the photospheric layers of spots with a field strength of 600 to 1000 gauss, magnetohydrodynamic waves do contribute to the energy transfer but cannot explain the departure from radiative equilibrium. The overlying chromosphere does not differ essentially from an active chromosphere. Above spots with a field of 2000 to 3000 gauss, the lower chromosphere should be less bright than the active chromosphere. (auth)

823 STRUCTURE OF THE LOWER CHROMOSPHERE. Dubov, E. E. (Crimean Astrophysical Observatory, Moscow). Sov. Astron. AJ (Engl. Transl.), 11: 269-77(Sept.-Oct. 1967).

Translated from Astron. Zh., 44: 342-51(Mar.-Apr. 1967).

The results are reported of observations of large-scale chromospheric structure with an interference–polarization filter at the center and in the wings of the Hα line. These observations are compared with each other and with spectroheliograms in Hα and $K_{3\,2\,1}$ for undisturbed and active regions on solar disk. The large-scale structural features of the lower chromosphere observed by the two methods are explained by changes in the location of the upper and lower boundaries of the lower chromosphere due to variations in the magnetic field and in the energy flux in various types of waves heating the chromosphere. The problems of defining the concept of a lower boundary for the chromosphere, turbulence in the chromosphere, and the resonance properties of the lower chromosphere are discussed. (auth)

824 SCATTERING OF SOLAR LYMAN-α RADIATION BY GALACTIC HYDROGEN. Kurt, V. G.; Germogenova, T. A. (Shternberg Astronomical Inst., Moscow). Sov. Astron. AJ (Engl. Transl.), 11: 278-82(Sept.-Oct. 1967).

Translated from Astron. Zh., 44: 352-7(Mar.-Apr. 1967).

The problem of coherent scattering of Lyman-α radiation in a homogeneous, isotropic medium containing a point source surrounded by a cavity is considered. A comparison of the theory with the intensity observed in the solar system indicates that the H II zone around the sun has a radius $\geq 10^3$ A.U. However, the nature of the hot ($T \approx 10^5$°K) hydrogen atoms with a concentration $\approx 10^{-2}$ cm^{-3} near the Earth's orbit remains an open question. (auth)

825 PERIODICITY IN THE NORTH–SOUTH ASYMMETRY OF THE SUNSPOT DISTRIBUTION AT THE MINIMUM OF NEW CYCLES. Berdichevskaya, V. S. (Kuibyshev Civil Engineering Inst., Moscow). Sov. Astron. AJ (Engl. Transl.), 11: 283-4 (Sept.-Oct. 1967).

Translated from Astron. Zh., 44: 358-60(Mar.-Apr. 1967).

The weighted mean latitude for the sunspots of new cycles in years of minimum is examined at the beginning of nine cycles, from 1879 to 1964. The sign and value of this parameter vary with a period of about 55 years. (auth)

826 ABSOLUTE EMISSION-LINE INTENSITIES IN PLANETARY NEBULAE. III. Vorontsov-Vel'yaminov, B. A.; Kostyakova, E. B.; Dokuchaeva, O. D.; Arkhipova, V. P. (Shternberg Astronomical Inst., Moscow). Sov. Astron. AJ (Engl. Transl.), 11: 285-9(Sept.-Oct. 1967).

Translated from Astron. Zh., 44: 361-7(Mar.-Apr. 1967).

Emission-line intensities are determined in absolute energy units (erg/cm^2 · sec) for 86 planetary nebulae. These nebulae are located in the galactic-center direction; their integrated magnitude is $\approx 13^m$. The observational material consists of 11 plates covering the region $\alpha = 17^h10^m$ to 18^h40^m, $\delta = -20°$ to $-30°$, and was obtained with the 70-cm meniscus telescope, equipped with objective prism, of the Abastumani Astrophysical Observatory (dispersion, 160 A/mm at Hγ). The procedures for reducing the spectrograms and deriving absolute emission-line intensities have been described proviously. The intensity of the Hα line only was measured for 59 nebulae, but for 27 others the intensities of 2 to 15 lines could be determined in the spectral range 3700 to 6700 A. These are the first absolute measurements of monochromatic flux for 81 nebulae; the great majority of the nebulae investigated had not previously been studied spectroscopically. The relation is examined between the apparent distribution of planetaries in the galactic-center direction and the absorption in that zone. Some indication is found of a possible physical distinction between the planetaries observed in the galactic-center direction and those located elsewhere. (auth)

827 REFLECTION COEFFICIENT FOR A PLANE-LAYERED LUNITE MEDIUM FOR DIFFERENT ANGLES OF INCIDENCE OF ELECTROMAGNETIC WAVES. Matveev, Yu. G. (Gorky State Univ., USSR). Sov. Astron. AJ (Engl. Transl.), 11: 332-6(Sept.-Oct. 1967).

Translated from Astron. Zh., 44: 419-25(Mar.-Apr. 1967).

The reflection coefficient for a nonhomogeneous, plane-layered medium has been computed for the case when the refractive index of this medium changes exponentially from some value at the surface to another value at depth. It is shown that the dependence of the reflection coefficient of such a medium on angle coincides with the angular dependence of the reflection coefficient of a homogeneous medium for some effective value of the refractive index, determined on the condition of equality of the reflection coefficients of both media with normal incidence of electromagnetic waves. Since the reflection coefficient of a layered medium is dependent on wavelength, the effective refractive index also is a function of λ. An approximate frequency dependence of the effective refractive index as a function of the depth of the nonhomogeneity has been obtained. It is concluded that the Fresnel formulas are applicable for computing integrated lunar radio emission, despite the existence of a certain nonuniformity of properties with depth. (auth)

828 MEASUREMENT OF RADIO EMISSION FROM THE MOON IN THE 30 TO 60 cm BAND. Troitskii, V. S.; Krotikov, V. D.; Tseitlin, N. M. (Gorky State Univ., USSR). Sov. Astron. AJ (Engl. Transl.), 11: 327-8(Sept.-Oct. 1967).

Translated from Astron. Zh., 44: 413-15(Mar.-Apr. 1967).

The radio emission from the Moon was measured by comparison with that from Cassiopeia and, in certain cases, from Taurus and Virgo, the intensity of which was calibrated by the "artificial moon" method. The mean radio temperature of the moon in the

30 to 60 cm band is independent of wavelength; its value is 225°K with an accuracy of ±3%. (auth)

829 PECULIAR MOTIONS OF O AND B STARS. Shatsova, R. B. (Rostov-on-Don Pedagogical Inst., USSR). Sov. Astron. AJ (Engl. Transl.), 11: 313-23(Sept.-Oct. 1967).

Translated from Astron. Zh., 44: 396-409(Mar.-Apr. 1967).

The observed velocities of O and B stars have practically the same distribution within 0.5-kpc radius of the Sun and in three associations (I Per, II Cep, I Mon). This is also true of O and B emission-line stars. The component in the galactic plane has a dispersion of 9 to 11 km/sec; the parameter C in the "Planck" velocity formula is 45 to 57 km/sec. From the second moments, corrected for observational error, the portions representing expansion of an association and peculiar motions of stars inside the association are isolated. Smaller expansion velocities are found than those given by other authors. The peculiar-velocity dispersions in II Cep and I Mon are approximately the same as in I Per, and may be slightly smaller than for circumsolar B stars. Stars in the zone from 0.5 to 1 kpc have a considerably larger velocity dispersion, apparently because of the larger contribution from local motions of associations in this region. There is little difference between the O and B star velocity distributions for stars in the same region of space. The apparent excess of fast O stars reported by Blaauw could occur because O stars are usually drawn from a larger region than B stars. (auth)

830 CONDITIONS FOR THE PRESENCE OF A CORONA AROUND A STATIONARY, SPHERICALLY SYMMETRIC STELLAR SYSTEM. Ogorodnikov, K. F. (Leningrad State Univ.). Sov. Astron. AJ (Engl. Transl.), 11: 308-12(Sept.-Oct. 1967).

Translated from Astron. Zh., 44: 390-5(Mar.-Apr. 1967).

The star-density distribution in the corona of a stationary, spherically symmetric system is calculated. The system is assumed bounded by a sphere of radius r_0; the star density $\nu = \nu_0$ at each point, and the velocity distribution is Maxwellian. The corona consists of stars that have emerged from the system ("ballistic" stars). The coronal density distribution is described and the description is applied to Kholopov's star counts in the globular cluster M4. Kholopov distinguishes three zones on the $\nu(r)$ curve, separated by sharp changes in the density gradient: I, the nucleus of main body; III, the corona; and in intermediate zone II. From the viewpoint of the theory developed here, zone II is a coronal region where there is still a significant number of "satellite" stars having low-eccentricity orbits contained wholly within the zone. A value of order 10^4 $m_\odot$ is derived for the cluster mass. (auth)

831 INVESTIGATION OF THE CRAB NEBULA AT 8.2 mm. Matveenko, L. I.; Pavlov, A. V. Sov. Astron. AJ (Engl. Transl.), 11: 300-1(Sept.-Oct. 1967).

Translated from Astron. Zh., 44: 381-3(Mar.-Apr. 1967).

The brightness distribution of the Crab Nebula was measured at 8.2-mm wavelength with 2'.14 resolution; the method is described and the results reported. At this wavelength the center of gravity is displaced NW of the binary star by $\Delta\alpha = -14'' \pm 20''$, $\Delta\delta = +22'' \pm 20''$. The radio isophote at the 3-dB level coincides in shape and position with the brightest part of the amorphous mass. (auth)

832 INFLUENCE OF LINE ABSORPTION ON THE INTERNAL STRUCTURE OF MASSIVE STARS. Imshennik, V. S.; Nadezhin, D. K. Sov. Astron. AJ (Engl. Transl.), 11: 297-9 (Sept.-Oct. 1967).

Translated from Astron. Zh., 44: 377-80(Mar.-Apr. 1967).

The influence of absorption due to bound–bound transitions in heavy-element atoms upon the structure of massive main-sequence stars is examined. The increase in opacity through line absorption results in an increase of 4% or 8% in the radius of a Population-I star having $M = 4M_\odot$ or $1M_\odot$ respectively, but the luminosity remains almost invariant. The effect should be smaller for more massive stars and Population-II stars. (auth)

833 NUCLEAR EFFECTS OF SOLAR AND GALACTIC COSMIC-RAY PARTICLES IN NEAR-SURFACE REGIONS OF METEORITES. Lal, D.; Rajan, R. S.; Venkatavaradan, V. S. (Tata Inst. of Fundamental Research, Bombay). Geochim. Cosmochim. Acta., 31: 1859-69(Oct. 1967).

Changes in isotopic composition in the near-surface regions of stone and iron meteorites due to nuclear processes associated with the low-energy solar and galactic cosmic-ray particles are evaluated theoretically. The processes considered are nuclear stopping due to ionization losses and nuclear interactions. It is shown that these effects, which are confined to the top few centimeters depth in meteorites, are distinguishable from the more permeating isotopic changes induced by energetic galactic cosmic rays. Studies in this field would allow more precise estimation of the parameters characterizing the continuous flux of low-energy galactic cosmic rays and the average flux of charged particles accelerated sporadically by the Sun during the last tens to hundreds of million years. Combining such information with measurements of the prehistoric rates of accretion of cer ain nuclides, e.g. ^{26}Al, (based on analysis of deep sea sediments), it should become possible to deduce the terrestrial accretion rate of cosmic dust during the past few million years. (auth) (UK)

834 METEORITES WITH SHORT COSMIC-RAY EXPOSURE AGES, AS DETERMINED FROM THEIR ^{26}Al CONTENT. Heymann, Dieter; Anders, Edward (Univ. of Chicago). Geochim. Cosmochim. Acta, 31: 1793-1809(Oct. 1967). (COO-382-73).

The ^{26}Al content was determined by $\gamma-\gamma$ coincidence spectrometry in thirty-one stony meteorites: ten carbonaceous, four enstatite, three bronzite, five hypersthene and five amphoteric chondrites; one angrite, one eucrite, one ureilite and one diogenite. In the following eight meteorites the ^{26}Al content was low enough to permit determination of a cosmic-ray exposure age (million years): Ivuna 0.18 ± 0.05, Cold Bokkeveld 0.32 ± 0.04, Nogoya 0.14 ± 0.08, Pollen 1.0 ± 0.5, Grosnaja 1.5 ± 0.4, St Marks 0.9 ± 0.2, Shaw 0.40 ± 0.07, Appley Bridge 1.5 ± 0.5. Seres and Bath showed gas contents suggesting ages $<1 \times 10^6$ yr, but their ^{26}Al contents correspond to ages ≥ 1.5 and $\geq 1.9 \times 10^6$ yr. These two discordant cases appear to be due to diffusion losses and a sample mixup, respectively. The Goalpara ureilite shows only about 60% of its expected ^{26}Al content. If this result is attributed to shielding, Goalpara must have had a preatmospheric mass of ≥700 kg. The mean ^{26}Al content found for sixteen samples of ordinary and enstatite chondrites is 63 dpm/kg, appreciably higher than the value of 47 dpm/kg determined by means of γ-ray spectrometry (Rowe et al., 1963). The discrepancy may be due to a calibration error in the latter method, and to sampling statistics. The present data scatter little from the mean, thus indicating a constant ^{26}Al production rate for most chondrites. Production rates of ^{26}Al in stony meteorites were estimated for the following target elements: Mg 85 ± 110, Al 410 ± 410, Si 210 ± 110, S 100 ± 90, Ca 280 ± 130, Fe + Ni 1.8 ± 0.6 dpm/kg. (auth) (UK)

835 RADIOACTIVITIES IN METEORITES AND COSMIC-RAY VARIATIONS. Fireman, E. L. (Smithsonian Astrophysical Observatory, Cambridge, Mass.). Geochim. Cosmochim. Acta, 31: 1691-1700(Oct. 1967).

The $^{22}Na/^{26}Al$ ratio in six recently fallen meteorites, including Přibram, and the $^{37}Ar/^{39}Ar$ ratio in three recently fallen meteorites were measured. The $^{22}Na/^{26}Al$ and $^{37}Ar/^{39}Ar$ ratios are indicators of variations in the cosmic-ray bombardment of meteorites. The $^{22}Na/^{26}Al$ ratios, which are produced by cosmic rays integrated over the meteoroid orbit, show that the 11-yr cosmic-ray variation is smaller at the average solar distance of most meteoroids than at 1 A.U. The $^{37}Ar/^{39}Ar$ ratios, which compare cosmic rays in the neighborhood of 1 A.U. with those at the average solar distance of the meteoroid, indicate high-energy cosmic-ray heliocentric radial gradient of 20 ± 8%/A.U. at solar maximum and at solar minimum. (auth) (UK)

836 ABUNDANCE ANOMALIES PRODUCED BY NUCLEAR REACTIONS IN STELLAR SURFACE LAYERS. I. NUCLEAR-REACTION RATES. Brancazio, P. J. (Goddard Space Flight Center, New York); Cameron, A. G. W.; Gilbert, A. Can. J. Phys., 45: 3275-96(Oct. 1967).

A preliminary investigation of the effects on abundances in stellar surfaces of extensive nuclear bombardment required the calculation of more than 10^5 nuclear reaction cross sections. It was necessary to develop simplified methods for using the statistical theory of nuclear reactions to make these calculations in order that the computer time should not be prohibitive. These methods are described here and the results are compared with experiment. The accuracy of the calculations is, in general, about as good as, or somewhat better than, that obtained in previous applications of the statistical theory, probably because the use of an accurate level density formula outweighed the crudity of other approximations. (auth)

837 QUASI-STELLAR SOURCES, SUPERNOVAE, AND NOVAE. Browne, P. F. (Univ. of Manchester, Eng.). Nature (London), 216: 229-32(Oct. 21, 1967).

By considering the opacity of a surface layer of a star it is concluded that quasi-stellar sources, supernovae, and novae may be different manifestations of the same mechanism. (auth) (UK)

838 DECAMETRIC RADIO EMISSION FROM JUPITER. Slee, O. B.; Gent, H. (Royal Radar Establishment, Malvern, Eng.). Nature (London), 216: 235-8(Oct. 21, 1967).

Observations of the decametric radio emission from Jupiter establish the existence of a hitherto undetected sub-millisecond component. Bursts of between 0.2 and 10 msec are not due to

interplanetary scintillation but come from the planet itself. (auth) (UK)

839 EVIDENCE FOR LATTICEBANDS IN INTERSTELLAR GRAINS. Wickramasinghe, N. C. (Cambridge Univ., Eng.). Nature (London), 216: 249-50(Oct. 21, 1967).

There is considerable evidence from infrared photometry that the wavelength range 3 to 10μ is associated with strong emission and absorption of radiation by interstellar grains. It has also been observed that strong absorption occurs with some stars in the same wavelength range. The possibility is considered that grains with impurity induced emission and absorption bands in the 3 to 10μ waveband may account for the observed effects. Although it does not seem that grains in the general interstellar medium possess strong absorption bands at these wavelengths, the grains in localized H II regions may be different. Such grains are exposed to a high flux of energetic particles which could produce lattice defects and consequent changes in optical characteristics. Silicon crystals doped with Li and B impurities, and silicon crystals irradiated with thermal neutrons, show strong absorption bands at certain frequencies, and a similar effect has been reported at about 3μ for quartz crystals with H^- impurities. With irradiated graphite crystals absorption bands may be expected to occur in the waveband 3 to 10μ. (UK)

840 FRIEDMAN COSMOLOGICAL MODELS WITH BOTH RADIATION AND MATTER. Cohen, J. M. (Inst. for Space Studies, New York). Nature (London), 216: 249(Oct. 21, 1967).

An analytical solution of Einstein's field equations has recently been given which represents a homogeneous and isotropic Universe containing both radiation and dust; the space-like surface, on which the matter is co-moving, is flat. Using arguments based on Mach's principle, however, it has been argued that space is closed. This implies for a Friedman Universe that the curvature is positive. Using statistical arguments and observational data, however, it has been argued that the Universe can be described by an open Friedman model with negative curvature. This disagreement cannot at present be resolved, since the energy density of the Universe is not known with sufficient accuracy. For this reason all three Friedman cosmological models are considered. The situation is still further complicated since the mass density necessary for the binding of our cluster of galaxies is much larger than that observed. (UK)

841 RAYLEIGH SCATTERING PROBLEM IN STELLAR ATMOSPHERES. Bond, G. R.; Siewert, C. E. (North Carolina State Univ., Raleigh). Astrophys. J., 150: 357-9(Oct. 1967).

A rigorous calculation of the asymtotic extrapolation distance for the Milve problem in a free-electron atmosphere is presented. (auth)

842 OBSERVATIONS OF THE EMISSION LINES OF Fe XIII DURING THE SOLAR ECLIPSE OF MAY 30, 1965. Eddy, John A.; Malville, J. McKim (High Altitude Observatory, Boulder, Colo.). Astrophys. J., 150: 289-97(Oct. 1967).

Photoelectric measurements made during the eclipse of May 30, 1965, show linear polarization of λ10747 ranging between 8 and 30%. Observations were made at four positions in the corona between 1.2 and 1.72 solar radii. The electric vector of λ10747 is found to be approximately radial. From the observed line to continuum ratios the estimated abundance of iron relative to hydrogen is approximately 8×10^{-5}. (auth)

843 AIRBORNE SPECTROGRAPHIC OBSERVATIONS OF THE SOLAR ECLIPSE OF NOVEMBER 12, 1966. Conway, John G. (Univ. of California, Berkeley); Morris, William F.; Andrews, C. Frederick. Contract W-7405-eng-48. Astrophys. J., 150: 299-301(Oct. 1967). (UCRL-17506).

Two spectrographs were flown on a C135 aircraft and used to observe the eclipse of November 12, 1966. Temperature measurements using 5303 and 6374 Å give $2.5\ 10^6$ and 1.8×10^6°K. Limb-to-corona intensity profiles are given. Ca II H and K lines are observed at 2 solar radii. (auth)

844 SOLAR LOOP PROMINENCES: A THEORETICAL MODEL. Olson, Carl A.; Lykoudis, Paul S. (Purdue Univ., Lafayette, Ind.). Astrophys. J., 150: 303-12(Oct. 1967).

A theoretical model of the loop prominence–flare event is given, in which the compression by the magnetic fields which may cause the solar flare is also made to cause the loop prominence. This model is based on the condensation theory of prominences, in which a plasma compressed by a magnetic field loses heat by conduction and radiation. The model is used to get time–height graphs of the loop prominence–flare event which show good agreement with observations up to altitudes of about 30,000 km. This is done for compression times of 500 to 1000 sec. The family of curves in the time–height graphs are obtained by varying the initial temperatures. It is shown that the way in which the final density was reached during the compression, or using various types of compression, did not significantly affect the results. Condensation theories have been criticized in the past due to the difficulties of supplying sufficient mass. It is shown in the present model that sufficient mass for the region in which the model is valid can be supplied from the coronal condensation. Since the model in question seems to be valid only for the lower loops of the loop-prominence system, it is suggested that the fast-particle theory of loop prominences might be valid in the higher regions. (auth)

845 MAGNETIC FIELDS IN QUIESCENT SOLAR PROMINENCES. I. OBSERVATIONS. Rust, David M. (High Altitude Observatory, Boulder, Colo.). Astrophys. J., 150: 313-26 (Oct. 1967).

A new magnetograph, operated on the Hα emission line, was used to measure the line-of-sight field intensity in nearly 100 quiescent prominences. The magnetic sensitivity was 2 gauss. The measurement technique is described. The observed prominences were divided into three classes roughly according to their position with respect to active regions. High-latitude ("polar crown") prominences most distant from the current sunspot zone usually showed fields of about 5 gauss. More recently formed prominences near the high-latitude border of fading bipolar magnetic regions also showed 5 gauss fields. The third class, sunspot zone prominences, showed fields up to 60 gauss; however, the median field was only about 8 gauss. The observations of the field intensity and polarity indicate that these are determined by nearby and underlying photospheric fields. The characteristic size of the overall field structures supporting prominences must be about 50,000 to 100,000 km. The pattern of polarities observed in the aged polar crown shows that there is no detectable large scale ($\approx R_\odot$) distortion of the lines of force in the solar atmosphere by the differential rotation. Observations at 20'' resolution reveal that the horizontal field intensity usually increases with height above the limb. This observed height gradient, $\partial H/\partial z \approx 10^{-4}$ gauss/km, is necessary and sufficient to demonstrate the support of prominences by Lorentz forces. The observations tend to confirm the validity of the theoretical prominence model of Kippenhahn and Schlüter. (auth)

846 FURTHER OBSERVATIONS OF PLANETARY NEBULAE AT 10 CM WAVELENGTH, INCLUDING THE PECULIAR NEBULA NGC 6302. Thompson, A. R.; Colvin, R. S. (Stanford Univ., Calif.). Astrophys. J., 150: 345-8(Oct. 1967).

Flux densities of 32 planetary nebulae additional to those observed by Thompson, Colvin, and Stanley are given for a wavelength of 10 cm. The peculiar nebula NGC 6302 is included and appears to have a thermal spectrum. (auth)

847 INFRARED SPECTRAL CLASSIFICATION OF HETZLER STARS. Albers, Henry (Vassar Coll. Observatory, Poughkeepsie, N. Y.). Astrophys. J., 150: 349-54(Oct. 1967).

In view of the interest in infrared stars and the general lack of spectral classifications available for them, some material obtained at the Warner and Swasey Observatory several years ago for the purpose of classifying the Hetzler stars was re-examined, and the results are presented. (W.D.M.)

848 NITROGEN DEFICIENCY IN TWO SUPERGIANTS. Jaschek, Mercedes; Jaschek, Carlos (Ohio State Univ., Columbus. Ohio Wesleyan Univ., Delaware. La Plata Observatory, Argentina). Astrophys. J., 150: 355-6(Oct. 1967).

During the current program of spectral classification of southern stars, plates of the supergiant HD 96248 were taken at J. D. 2438848 and 2438861. This supergiant was compared with a northern supergiant HD 14443 and both were found to exhibit a peculiar behavior of the N II lines. (W.D.M.)

849 RELATIVE ABUNDANCES IN THE SOLAR CORONA AS DETERMINED FROM THE ULTRAVIOLET SPECTRUM. Pottasch, S. R. (Kapteyn Astronomical Lab., Groningen, Netherlands); Athay, R. Grant. Astrophys. J., 150: 361-7 (Oct. 1967).

Recently Athay (1966) commented on the interpretation of the solar ultraviolet data and, in particular, on the analysis and interpretation (Pottasch 1963 a) of these data. Athay took issue with the resultant abundance values obtained. Several comments are made on Athay's paper. Athay in turn comments on the comments made by Pottasch. (W.D.M.)

850 RADIO OBSERVATIONS OF GALAXIES. De Jong, Marvin L. (Ohio State Univ., Columbus). Astrophys. J., 150: 1-8(Oct. 1967).

Observations of 74 galaxies at 2695 MHz (11 cm) are described. Flux densities and positions relative to the optical objects are given for most of the radio sources. The 11-cm data, when com-

bined with existing data at 40 cm and 11 cm, show that the radio-frequency spectra of the normal spiral galaxies observed in this investigation generally curve downward in the frequency range 750 to 2695 MHz. No evidence was found for a thermal component in the radio emission of spiral galaxies. Interesting spectra of other galaxies are illustrated. The radio properties of spiral galaxies are briefly discussed. (auth)

851 NEUTRAL HYDROGEN STUDIES OF GALAXIES WITH A SINGLE-SPACING INTERFEROMETER. Rogstad, D. H. (California Inst. of Tech., Pasadena); Rougoor, G. W.; Whiteoak, J. B. Astrophys. J., 150: 9-31(Oct. 1967).

A total of 79 galaxies were investigated with the Owens Valley Observatory's two-element interferometer for detectability of neutral hydrogen. The baseline used was 100 feet east-west, and the filter band width was 100 kHz. Thirty of the galaxies had detectable emission ($>0.5 \times 10^{-26}$ W m^{-2} Hz^{-1}). The results are presented as line and position profiles for each galaxy (i.e., plots of the flux density, and its position, derived from the interferometer phase, as a function of radial velocity). An extensive investigation of model profiles is also presented for the purposes of interpretation of the observed results. It is shown that, while in most cases the position profile cannot be directly interpreted as the rotation curve, the model analysis does suggest a method for estimating the rotational characteristics of the galaxies from the profiles. Using the estimated rotational parameters, total masses were calculated and are presented along with other quantities that describe the character of the galaxies. All of the irregular galaxies that were detected were found to be rotating, with the exception of WLM, which was inconclusive. (auth)

852 A MECHANISM FOR MASER ACTION OF OH MOLECULES IN INTERSTELLAR SPACE. Johnston, Ian D. (Univ., Sydney). Astrophys. J., 150: 33-45(Oct. 1967).

It is suggested that collisions between OH molecules and charged particles will discriminate between the different energy levels involved in the 18-cm wavelength transitions observed by radio astronomers, and hence could be responsible for a masering action on a vast scale. The basic atomic physics of the collision is analyzed, showing how this discrimination arises and what its consequences are in terms of observed microwave radiation. This simple collision process is then discussed in a kinetic theory context and results are derived which, though still highly idealized, have some point of contact with the real world. Finally, the general nature of the effect having been established, an attempt is made to show how it could be observed in interstellar space, and how it could be fitted to the OH observations in particular. (auth)

853 HIGH-ENERGY X RAYS FROM CYGNUS XR-1. Overbeck, James W.; Womack, E. Allen; Tananbaum, Harvey D. (Massachusetts Inst. of Tech., Cambridge). Astrophys. J., 150: 47-56(Oct. 1967).

On September 19, 1966, a balloon-flown, oriented scintillation counter with good energy resolution was used to measure x rays above 15 keV from Cygnus XR-1 and to search for x rays from Cassiopeia A and the remnant of Tycho's supernova (SN 1572). Knowledge of the counter's orientation has permitted a conclusion that the x rays between 23 and 97 keV observed from the Cygnus region came from Cygnus XR-1 rather than from Cygnus A or Cygnus X. Cygnus XR-2 was never in the counter's field of view. By comparing the data with those of McCracken evidence is found for a decrease in flux from Cygnus XR-1 at high energies, although not so large as that at low energies reported by Byram, Chubb, and Friedman. No positive flux of high-energy x rays was found above the background from Cas A and SN 1572. The absence of a positive high-energy flux from these sources is not inconsistent with Byram et al.'s detection of weak fluxes from them at lower energies, provided that their energy spectra are as steep as that of Sco X-1. If one assumes x rays from Cas A and SN 1572 are produced in hot, optically thin, ionized gas the result, combined with that of Byram et al. implies a characteristic temperature less than 8.5×10^{8}K for the gas. (auth)

854 X-RAY INTENSITIES AND SPECTRA FROM SEVERAL COSMIC SOURCES. Chodil, G.; Mark, Hans; Rodrigues, R.; Seward, F. D.; Swift, C. D. (Univ. of California, Livermore). Contract W-7405-eng-48. Astrophys. J., 150: 57-65(Oct. 1967). (UCRL-70335).

The results of X-ray spectrum and intensity measurements for several cosmic x-ray sources are reported. Two flights were conducted, one from Kauai, Hawaii on July 28, 1966, and the other from Johnston Atoll on September 20, 1966. Proportional counters with anticoincidence shields to eliminate charged-particle background counts were used to detect the x rays. Four known sources were observed: Sco XR-1, Tau XR-1, Cyg XR-1, and Cyg XR-2. Total intensity determinations were made for all of these sources, and spectra were obtained for Sco XR-1 and Cyg XR-2. A search was made for x rays from the Large and Small Magellanic Clouds, but no x rays above background were found in that region of the sky. An upper limit of the x-ray intensity from the Magellanic Clouds has been determined from these data. A weak x-ray source not previously observed was found in the constellation Vela (Vel XR-1). (auth)

855 THE CRAB NEBULA AT 1420 MHz. Krishnan, T. (Stanford Univ., Calif.); Zisk, S. H.; Cudaback, D. D. Astrophys. J., 150: 67-77(Oct. 1967).

A lunar occultation of the radio source Taurus A (the Crab Nebula) at 1420 MHz was observed with the University of California's 85-foot paraboloid and the results are presented. The high resolution (30″ for the best signal/noise ratio) enabled a precise position to be obtained [R.A. (1950.0): $05^{h}\ 31^{m}\ 30^{s}5$; decl. (1950.0): +21°59′01″] as well as a determination of the strip brightness distributions at position angles 115° and 241°, through restoration. It is shown that the position of the peak of the 1420 MHz source agrees most closely with the peak in the optical continuum (5200 to 6400 Å), and that the two distributions agree remarkably well too. A comparison with other radio-frequency occultation observations shows that the distribution of the emission is not simply explained by the presence of the low-frequency (~25 MHz) source in Taurus; spectral differences in other parts of the nebula seem to exist, as indicated by positional differences, spectral variations, and changes in the axial ratio of the almost elliptical nebula. (auth)

856 LYMAN-ALPHA RADIATION DENSITIES IN PLANETARY NEBULAE. Capriotti, Eugene R. (Ohio State Univ., Columbus. Ohio Wesleyan Univ., Delaware). Astrophys. J., 150: 79-94(Oct. 1967).

The average Ly-α radiation density is estimated for each of several model nebulae using available theories and modifications of the available theories of Ly-α scattering in gaseous nebulae. On the assumption that the 2^3S state of He I is depopulated via photo-ionization by Ly-α radiation, the average Ly-α radiation densities were previously calculated by O'Dell for nine planetary nebulae from the observed ratios of the intensities in the λ10830 and λ5876 lines. Comparisons to the model calculations are made. For two of the nebulae it seems that the Ly-α radiation densities as determined from the λ10830/λ5876 line intensity ratios may represent the actual Ly-α radiation densities. For the remaining nebulae, it seems that the observationally determined Ly-α radiation densities are representative only if some combination of the following conditions is fulfilled in each case: 1. The optical thickness at the hydrogen Lyman limit in the continuum of the object increases as the surface brightness decreases, a behavior in conflict with previous concepts regarding planetary nebulae of this size range. 2. The object is essentially optically thick in the hydrogen Lyman continuum when other properties of the object show it to be optically thin in the hydrogen Lyman continuum. 3. We happen to be viewing the object during a specific 100-year time span during the course of its evolution, since the Ly-α radiation pressure that corresponds to the Ly-α radiation density needed to account for the observed rate of depopulation of the 2^3S state of He I would set up velocity gradients in that time that would decrease the effective optical depth in Ly-α to the extent where the Ly-α radiation densities would no longer be large enough to ionize He I in the $2^3S \rightarrow$ continuum transition at the observed rate. (auth)

857 THE DEPOPULATION RATE OF THE 2^3S STATE OF HELIUM IN PLANETARY NEBULAE. Capriotti, Eugene R. (Ohio State Univ., Columbus. Ohio Wesleyan Univ., Delaware). Astrophys. J., 150: 95-103(Oct. 1967).

The depopulation rates of the 2^3S state of helium are predicted for several planetary nebulae on the assumption that the mechanisms for depopulation are two-photon decay, collisional transitions to the ground state and the 2^1S state, photo-ionization by Ly-α radiation, and photo-ionization by stellar continuous radiation. An attempt is made to establish depopulation rates from the observed I(λ10830)/I(λ5876) ratios and from considerations of self-absorption of lines formed in the ($n^3P - 2^3S$) transitions. There appears to be fair agreement between the predicted depopulation rates and those determined from the self-absorption considerations. However, the disagreement, in general, between the rates deduced from observations, using two different methods, is so strong that we are unable to draw meaningful conclusions regarding the accuracy of the predicted rates. In other words, we have not been able to set the criteria for determining good test depopulation rates of the 2^3S state of helium in planetary nebulae. (auth)

858 THERMAL INSTABILITY RESULTING FROM SYNCHROTRON RADIATION. Simon, M.; Axford, W. I. (Cornell Univ., Ithaca, N. Y.). Astrophys. J., 150: 105-13(Oct. 1967).

The thermal instability of a medium containing relativistic electrons is discussed. The energy losses that govern the process are those due to synchrotron radiation and the inverse Compton effect.

It is argued that filamentary condensations in the medium will grow only if their wave normals are essentially perpendicular to the magnetic field, since the thermal conductivity is heavily reduced in this direction and cannot quench the instability. Provided there is some continuing source of relativistic electrons, thermal instability can occur, but if there is no such source, small condensations initially present eventually decay after a short period of growth. A criterion for instability is given, and it is shown that disturbances with sufficiently short wavelengths grow at the maximum rate. As an example the results are applied to the case of the Crab Nebula. (auth)

859 TYPE-I SUPERNOVAE. Finzi, A.; Wolf, R. A. (California Inst. of Tech., Pasadena). Astrophys. J., 150: 115-29(Oct. 1967).

It is suggested that type-I supernovae result from massive white dwarfs that implode catastrophically at the end of very slow contractions. These slow contractions, which should in some cases require times of the order of the age of the Galaxy, are caused by inverse β processes that take place in the interiors of the stars. Two classes of white dwarfs have been found that could meet the obvious requirements involving the contraction times and the observed frequency of type-I supernovae. The white dwarfs of the first class have masses of about 1.40 M$\odot$ and cores with ~10% ^{24}Mg. Those of the second class have masses of about 1.20 M$\odot$, ^{56}Fe cores, and intermediate shells with a small concentration of ^{40}Ca. Consideration of pre-white-dwarf evolution does not reveal any obvious reason why white dwarfs of either one of the two classes could not be formed. One is thus unable to tell whether type-I supernovae should be identified with ^{24}Mg white dwarfs or with ^{40}Ca white dwarfs. The luminosities of the contracting white dwarfs are estimated and their observability is discussed. The question of the creation of a neutron star in the final collapse is also discussed. (auth)

860 CARBON AND OXYGEN BURNING STARS AND PRE-SUPERNOVA MODELS. Rakavy, G. (California Inst. of Tech., Pasadena); Shaviv, G.; Zinamon, Z. Astrophys. J., 150: 131-62 (Oct. 1967).

Detailed evolutionary calculations of models composed of oxygen and carbon are presented. The evolution was followed up to final phases of evolution, the final model being a white-dwarf or a pre-supernova model. Stars are grouped according to the type of final model. It was found that models with masses greater than 2 M$\odot$ end their evolution with dynamical instability. Stars with masses in the range 1.44 to 2 M$\odot$ have not been investigated thoroughly; however, inverse beta decay may be important in the final stages of these stars. Stars with masses less than 1.44 M$\odot$ do not burn oxygen, and those with masses less than 1 M$\odot$ do not burn carbon either. (auth)

861 STELLAR COALESCENCE AND THE MULTIPLE SUPERNOVA INTERPRETATION OF QUASI-STELLAR SOURCES. Colgate, Stirling A. (New Mexico Inst. of Mining and Tech., Socorro). Astrophys. J., 150: 163-92(Oct. 1967).

The end-point evolution of a self-gravitating cluster of stars or a galactic nucleus is shown to result in the coalescence of stars to form massive ones necessarily before energetic collisions can disrupt them. The rapid evolution of the resulting massive stars (limited to 30 to 50 M$\odot$) gives rise to a maximum supernova rate in equilibrium with the cluster coalescence rate of 5 to 10 supernovae per year. The kinetic energy of the mass ejected by these supernovae (10^4 to 10^5 times the usual observed optical emission) is converted into heat by the collision with a gas cloud which is determined by the cluster gravitational field and the rate of supernovae. The gas-cloud thickness is approximately one Compton scattering mean free path ($R \simeq 10^{18}$ cm, $\rho = 2 \times 10^{-17}$ gm/cm^3). The principal optical emission occurs due to inverse Compton cooling of the electrons heated by the collisional dynamic friction of the matter ejected from the supernova at lower velocity. The higher-velocity fraction penetrates and escapes to a lower-density gas region, there exciting counter-streaming plasma oscillation of large amplitude. A new mechanism for radio emission occurs whereby the photons emitted by electrostatic bremsstrahlung (analogous to synchrotron emissions) are multiply scattered from the coherent plasma oscillations. These photons diffuse in momentum space to much higher frequencies before escaping. The resulting optical and radio emission spectra, magnitude, and fluctuations are in agreement with the Hubble Doppler shift interpretation of quasi-stellar observations. (auth)

862 PULSATIONAL INSTABILITY IN HELIUM SHELL-BURNING STARS. Rose, William K. (Princeton Univ., N. J.). Astrophys. J., 150: 193-202(Oct. 1967).

A detailed calculation is given for a 0.75 M$\odot$ helium shell-burning star with a pure helium envelope. For this star the nuclear burning at flash peaks is sufficient to cause pulsational instability by a wide margin. In addition, some of the 0.53 M$\odot$ models described in a previous paper are found to be pulsationally unstable. The presence of pulsational instability in the above models provides an additional physical basis for the suggestion that helium shell-burning stars may be connected with the origin of planetary nebulae and the occurrence of certain novae. Particular emphasis is given to a comparison between the final relaxation oscillation of the 0.75 M$\odot$ star and the observed evolutionary tracks for the nuclei of planetary nebulae. The influence of plasma neutrino emission on 0.75 M$\odot$ models is shown by means of a sequence of computed models. (auth)

863 THE PRINCIPLE OF EXCHANGE OF STABILITIES. II. THE ONSET OF CONVECTION IN THE PRESENCE OF ROTATION. Lebovitz, N. R. (Univ. of Chicago). Astrophys. J., 150: 203-12(Oct. 1967).

It is shown that a rotating star, like a nonrotating star, allows time-independent Lagrangian displacements of convective type if it contains an adiabatically stratified layer, but that, unlike the nonrotating case, the displacements in question continue to be of stable type even when the layer becomes superadiabatic. The calculations leading to the latter conclusion are carried out for the simpler, but formally similar, problem of a plane-stratified atmosphere. It is further shown that instability sets in through a Lagrangian displacement with a quadratic dependence on the time. This behavior is exploited to give a procedure for finding the critical wavenumber k_c such that unstable modes exist for $k > k_c$. This procedure is a generalization of that normally associated with the principle of exchange of stabilities. (auth)

864 ADIABATIC PULSATIONS AND CONVECTIVE INSTABILITY OF GASEOUS MASSES. I. Tassoul, Monique; Tassoul, Jean Louis (Univ. of Chicago). Astrophys. J., 150: 213-21(Oct. 1967).

The adiabatic pulsations of a homogeneous prolate spheroid subject to the tidal action of a secondary rigid body are considered. It is shown that the presence of an external mass partially removes the degeneracy of the fundamental modes belonging to the first spheroidal harmonics. The p modes are strongly affected but remain always stable when the adiabatic exponent γ is greater than unity. The g modes, on the contrary, are nearly independent of the tidal force, except for values of the eccentricity e close to unity. In any case, the tidal action cannot entirely remove the convective instability of a homogeneous spheroid. The third-order virial equations also exhibit the existence of an f mode belonging to the third spheroidal harmonics which, in agreement with previous works, becomes unstable if e is greater than the critical value 0.94774. This mode is almost independent of the compressibility of the system. (auth)

865 THE PERIOD–COLOR–LUMINOSITY RELATION OF BETA CANIS MAJORIS STARS. Leung, Kam-ching (Univ. of Pennsylvania, Philadelphia). Astrophys. J., 150: 223-7(Oct. 1967).

Visual absolute magnitudes were obtained from spectroscopic Hγ equivalent widths of seventeen β Canis Majoris stars. A period-luminosity relation and a period–color–luminosity relation were derived. Their probable errors in M_v were found to be ±0.14 and ±0.11, respectively. The period–color–luminosity relation leads to the existence of a set of linear equal period contours across the instability strip in the H–R diagram. (auth)

866 ROTATIONAL BEHAVIOR OF THE MAIN-SEQUENCE STARS AND ITS PLAUSIBLE CONSEQUENCES CONCERNING FORMATION OF PLANETARY SYSTEM. II. Huang, Su-shu (Northwestern Univ., Evanston, Ill.). Astrophys. J., 150: 229-38(Oct. 1967).

Following the view taken in a previous paper that the statistical behavior of the observed rotational velocities of stars depends upon the braking mechanism, several statistical models based on the truncated Maxwellian distributions of original stellar angular momenta as well as on different braking processes were studied. Observational results appear to indicate that the rate of decrease of angular momentum of a star at any moment must be proportional to the first or/and higher powers of the angular momentum itself. No constant term should occur in the braking equation. Arguments are advanced to show that the braking of stellar rotation leads to formation of planetary systems. Therefore the observed statistical property of early-type main-sequence stars that rotate rapidly may be used as giving an estimate for the frequency distribution of planetary systems around the late-type main-sequence stars that do not rotate significantly. (auth)

867 ABSOLUTE MAGNITUDE AND EFFECTIVE TEMPERATURE OF THE HYDROGEN-POOR STAR HD 30353. Danziger, I. J. (Carnegie Institution of Washington, Washington, D. C.

California Inst. of Tech., Pasadena); Wallerstein, George; Bohm-Vitense, Erika. Astrophys. J., 150: 239-44(Oct. 1967).

Interstellar polarization and reddening data for stars near HD 30353 were used to obtain a reddening excess E(B−V) = 0.35 and an absolute visual magnitude of −3.2. An effective temperature of 10,000°K for HD 30353 was obtained by fitting photoelectric scans of the continuum to fluxes obtained from the model atmosphere of a hydrogen-poor star. (auth)

868 ABUNDANCES OF THE LIGHT ELEMENTS IN THE HYDROGEN-POOR STAR HD 30353. Wallerstein, George; Greene, Thomas F.; Tomley, Leslie J. (Univ. of Washington, Seattle). Astrophys. J., 150: 245-55(Oct. 1967).

A coarse analysis of the hydrogen-poor star HD 30353 was performed in order to provide first-order abundances of the light elements. High-dispersion spectrograms (8 to 15 Å/mm) and absolute gf-values were used to derive atmospheric parameters. Stratification effects are evident in the excitation temperature which was found to vary from $\theta = 0.85$ for Fe I to $\theta = 0.45$ for Si II. With $\theta_{ion} = 0.50$, the electron pressure was found to be 2 dynes/cm^2 to explain the ionization of nitrogen, silicon, and sulfur. The ratio of H/He of 10^{-4} was found from the comparison of the observed profile of H_γ and profiles computed from model atmospheres. Nitrogen is the second most abundant element and the ratios of $N_C/N_N = 10^{-3}$ and $N_O/N_N = 2 \times 10^{-2}$ were found from curves of growth. The abundances of neon, silicon, and sulfur were found to be normal. The low hydrogen abundance and the rearrangement of the CNO nuclei are discussed in terms of mass loss and carbon cycling. (auth)

869 ABUNDANCES OF IRON-PEAK ELEMENTS IN HD 122563 FROM ULTRAVIOLET SPECTRA. Wolff, Sidney Carne (Univ. of California, Berkeley); Wallerstein, George. Astrophys. J., 150: 257-62(Oct. 1967).

Equivalent widths of 143 absorption lines in the region of 3400 to 3900 Å were used to improve the analysis of the atmosphere and composition of the metal-poor star HD 122563. Both neutral and ionized lines were used to derive the relative abundances of the iron-peak elements and Sc, Y, and Zr. The even-odd elements, V, Mn, and Co, are deficient with respect to the even-even elements, Cr, Fe, and Ni, by a factor of 2.5 as compared to their ratios in the Sun. Sc, Y, and Zr have about the same abundance relative to iron as they have in the Sun. The relative abundances of the iron-peak elements have been compared with calculations by Clifford and Tayler of equilibrium distributions of nuclei at high temperatures. If the iron-peak elements in this star were formed under such equilibrium conditions, the density of the material was in the range 10^6 to 10^9 gm/cm^3; the ratio of total protons to neutrons was in the range of 0.825 to 0.875; and the temperature was within the limits 2 to 3×10^9°K with some preference that it be closer to 3×10^9 than to 2×10^9°K. The wavelength dependence of the opacity was derived using iron lines from 3400 to 6400 Å. The opacity can be understood in terms of both H^- and Rayleigh scattering making an equal contribution at 3500 Å. (auth)

870 A FINE ANALYSIS OF TWO YELLOW SUPERGIANTS. I. PRELIMINARY RESULTS. Parsons, Sidney B. (Case Western Reserve Univ., Cleveland). Astrophys. J., 150: 263-71 (Oct. 1967).

Results are presented of a comparison between approximate line-blanketed, convective model atmospheres and equivalent widths, measured from 120-inch coudé spectrograms, of about 130 metallic lines in the spectra of α Per and β Aqr, types F5 Ib and G0 Ib. Effective temperatures of 6250° ± 150° and 5650° ± 150°K are indicated for these two stars. The surface gravities, log g, are on the order of 1.8 for both. The amount of microturbulence in both atmospheres increases with height, having a value of about 5 km/sec at optical depth 0.2. There is virtually no macroturbulence or rotation in β Aqr, while α Per has about 10 km/sec of macroturbulence or 15 km/sec of rotation. Most elements have essentially solar abundances, although both stars show large nitrogen−carbon ratios. (auth)

871 DEPENDENCE OF DECAMETRIC RADIO EMISSION FROM JUPITER ON THE POSITIONS OF THE FIRST TWO GALILEAN SATELLITES. Tiainen, P. O. (Technical Univ. of Helsinki). Nature (London), 215: 1467-8(Sept. 30, 1967).

Jovian decametric radio emission is controlled by Io, the first Galilean satellite of the planet, and it has been assumed that the determining factor is the position of Io in its orbit as measured from superior geocentric conjunction or from superior heliocentric conjunction. It has also been shown that the probability of emission is dependent on the position of Io with respect to the plane which contains the magnetic axis of the planet. This communication describes a statistical analysis of observations of the decametric radio emission between 1961 and 1965, made at Boulder, Colorado. Correlations were sought between the emission in various frequency ranges and the position of the first three Galilean satellites of Jupiter with respect to the Sun, the Earth, and the plane which contains the Jovian magnetic axis. The data were stored on magnetic tapes and the search for the effects of the satellites was made by suitable computer programmes. (UK)

872 ON THE K LINE OF Ca II IN SUNSPOTS. Engvold, O. (Univ. of Oslo). Solar Phys., 2: 234-6(Sept. 1967).

According to Mustel and Tsap (1960) and Paciorek (1965) the K_3 absorption line disappears in the center of the sunspot umbrae. Bumba (1960), on the other hand, found that the K_3 absorption is present in the umbrae. In order to discriminate between the existing theories on the origin of the K-line emission it is important to know whether the K line is always doubly reversed, or if the sunspots make an exception. This problem was studied by investigating K-line spectra obtained at Oslo during 1966. The spectra were observed using a Babcock grating with 600 lines/mm, in the seventh order. The linear dispersion is 15.5 mm/Å, and 1 mm on the film corresponds to 4.7 sec of arc or approximately 3400 km on the Sun. (W.D.M.)

873 SECULARLY SMOOTHED DATA ON THE MINIMA AND MAXIMA OF SUNSPOT FREQUENCY. Gleissberg, W. (Univ., Frankfurt am Main). Solar Phys., 2: 231-3(Sept. 1967).

The epochs of the minima and maxima of sunspot frequency and their ordinates were taken from a table published by Waldmeier (1961). The data given in this note were added to the data taken from Waldmeier's table. Then secular smoothing was applied to all these data, i.e., to the epochs of minima and maxima during the period 1610 to 1964 and to their ordinates during the period 1698 to 1964. (W.D.M.)

874 THE VELOCITY FIELD SURROUNDING SUNSPOTS AS DERIVED FROM OBSERVATIONS OF Hα. Haugen, E. (Univ. of Oslo). Solar Phys., 2: 227-30(Sept. 1967).

During 1963−1967 several high-dispersion, Hα-line spectra of sunspots and their surroundings have been obtained at the Oslo Solar Observatory. Two thousand absorption elements found on these spectra were studied. The absorption elements are usually found outside the spot; in 95% of the cases the whole element is situated outside the spot penumbra. Most of the elements are situated close to the penumbral rim, but elements are found out to five sunspot radii from the spot center. (W.D.M.)

875 THE OSO-1 SOLAR NEUTRON EXPERIMENT. Hess, W. N. (Goddard Space Flight Center, Greenbelt, Md.); Kaifer, R. C. Solar Phys., 2: 202-10(Sept. 1967).

BF_3 counters on OSO-1 were used to look for solar neutrons by trying to observe a diurnal variation in count rate. No effect was observed and an upper limit was placed on the solar neutron flux at the earth of $J_n < 2 \times 10^{-3}$ neut/cm^2/sec of 10 keV < E_n < 10 MeV for the period March to May 1962. No proton-producing flares occurred during this time, so the most obvious source of solar neutrons could not be studied. The emulsion experiment of Apparao et al., flown during this period, which seemed to indicate solar neutrons has probably been misinterpreted. (auth)

876 OSCILLATOR STRENGTHS FOR RESONANCE LINES OF SOME SILICON AND SULFUR IONS. Kastner, Sidney O. (Goddard Space Flight Center, Greenbelt, Md.). Solar Phys., 2: 196-201(Sept. 1967).

Oscillator strengths are calculated for resonance lines of some silicon and sulfur ions, which are present in the solar spectrum from about 160 to 380 Å. Spin−spin and spin−other orbit interactions are included. A comparison is made with Garstang's results for Si X; agreement is good. (auth)

877 A SPECTACULAR ACTIVATION OF A PROMINENCE ON MARCH 25, 1967. Gimse, O.; Hosinsky, G. (Swedish Astrophysical Station, Anacapri, Italy). Solar Phys., 2: 192-5(Sept. 1967).

On March 25, 1967, a remarkable eruptive prominence, situated at 16°−44°S on the SE limb of the Sun, was observed with the Hα visual patrol instrument at Anacapri. The instrument is an 8-cm refracting telescope with focal length of 150 cm and with a 0.7 Å birefringent filter. In addition to the continuous visual observations of the event, about 80 exposures were obtained. (W.D.M.)

878 ENERGETIC PROTONS FROM THE SOLAR FLARE OF MARCH 24, 1966. Kahler, S. W.; Primbsch, J. H.; Anderson, K. A. (Univ. of California, Berkeley). Solar Phys., 2: 179-91 (Sept. 1967).

Ten to 100 MeV protons from the solar flare of March 24, 1966, were observed on the University of California scintillation counter on OGO-I. The short rise and decay times observed in the count rates of the 32 channels of pulse-height analysis show that scattering of the protons by the interplanetary field was much less important in this event than in previously observed proton flares. A dif-

fusion theory in which $D = Mr^{\beta}$ is found to be inadequate to account for the time behavior of the count rates of this event. Small fluctuations of the otherwise smooth decay phase may be due to flare protons reflected from the back of a shock front, which passed the Earth on March 23. (auth)

879 STUDY OF ENERGETIC SOLAR FLARE X RAYS. Arnoldy, R. L.; Kane, S. R.; Winckler, J. R. (Univ. of Minnesota, Minneapolis). Solar Phys., 2: 171-8(Sept. 1967).

A new series of solar flare energetic x-ray events has been detected by an ionization chamber on the OGO-I and OGO-II satellites in free space. These x rays lie in the range 10 to 50 keV, and a study has been made of their relationship to 3- and 10-cm radio bursts and with the emission of electrons and protons observed in space. The onset times, times of maximum intensity, and total duration are very similar for the radio and x-ray emission. Also, the average decay is similar and usually follows an exponential type behavior. However, this good correlation applies most often to the "flash" phase of flares, whereas subsequent surges of activity from the same eruption may produce microwave emission or further x-ray bursts not closely correlated. An approximate proportionality is found between the total energy content of the x rays and of the 3- and 10-cm integrated radio fluxes. These measurements suggest that the x ray and microwave emission have a common energizing process which determines the time profile of both. The recording of electrons greater than 40 keV by the Interplanetary Monitoring Probe (IMP satellite) has been found to correlate very well with flares producing x-ray and microwave emission provided the propagation path to the Sun is favorable. There is evidence that the acceleration of solar protons may not be closely associated with the processes responsible for the production of microwaves, x rays, and interplanetary electrons. The OGO ionization chamber responds to energies (10 to 50 keV) intermediate between the soft x rays giving SID disturbances (1 to 10 keV) and energetic quanta previously measured with balloons (50 to 500 keV). Proposed source mechanisms should be capable of covering this range of energies including the most energetic quanta occasionally observed. (auth)

880 FLARE POSITIONS RELATIVE TO PHOTOSPHERIC MAGNETIC FIELDS. Smith, Sara F.; Ramsey, Harry E. (Lockheed Solar Observatory, Burbank, Calif.). Solar Phys., 2: 158-70(Sept. 1967).

Of 21 flares of importance 1 or greater, observed on 15 days, all were found to lie adjacent to a neutral line in the longitudinal component of photospheric magnetic fields. In most of these cases, the flare consisted of two or more segments separated by the neutral line and located in areas of strong field and high-longitudinal field gradient. In some cases, the flare segments extended into areas of weak-magnetic field and low-field gradient, but maintained an orientation adjacent to a neutral line. Optical and magnetic field records of higher resolution were obtained on 6 July 1965. These observations reveal an excellent correlation between the size, shape, and intensity of the Hα fine structures and the longitudinal component of the photospheric magnetic fields, except in the vicinity of the neutral line. Sections of the neutral line are marked by long fibrils lying perpendicular to the neutral line or by small filaments lying along the neutral line. The development of a flare of importance 1 in this region appeared to be more precisely related to the neutral line than was found for the flares and magnetic fields observed with lower resolution. The two major segments of this flare lengthened in directions approximately parallel to the neutral line, while simultaneously drifting perpendicularly away from the neutral line. The initial rate of drift systematically varied from 1 to 12 km/sec at a series of positions approximately parallel to the neutral line and corresponding to increasing distance from strong fields. The rate of drift was also observed to decelerate throughout the life of the flare. (auth)

881 MODEL OF THE SUNSPOT UMBRA. Chitre, S. M.; Shaviv, G. (California Inst. of Tech., Pasadena). Solar Phys., 2: 150-7(Sept. 1967).

Equations governing the structure of the umbra of a single spot were integrated on the spot-axis. It is shown that a consistent umbral model can be obtained only for a narrow range of the electron pressures at the spot surface. The spot center is found to be at a depth of about 400 km below the normal solar surface. The reduced energy flux observed at the surface is assumed to be due to the effect of the spot-magnetic field on subphotospheric convection and an empirical factor β is introduced to take into account the reduction in the convective energy flux. With an inferred expression for β as a function of the internal and magnetic-energy density it is shown that in a consistent model the physical variables in the spot approach their ambient values at about 2330 km below the undisturbed solar surface and at the same depth the energy flux approaches the normal solar value and the magnetic interference with convection vanishes. The present investigation is a refinement of an earlier paper by Chitre (1963). (auth)

882 SOME PROPERTIES OF VELOCITY FIELDS IN THE SOLAR PHOTOSPHERE. Deubner, Franz Ludwig (Fraunhofer Institut, Freiburg 1. B.). Solar Phys., 2: 133-49(Sept. 1967).

Photoelectric records of the Doppler effect (DE) and longitudinal Zeeman effect (LZE) were obtained with the Capri magnetograph of the Fraunhofer Institut photoelectric, using the FeI line λ 5250.22. Each record consists of 65 scans repeated along the same line on the sun. The analysis of 16 records covering a total of 485 oscillating regions (period 300 sec) leads to the following results: (1) The mean lifetime of the DE oscillations outside active regions is 20 min and 32 min in the neighborhood of spotgroups. Discarding the weakest sporadic oscillations, one obtains 27 min and 43 min respectively. The most frequent lifetime in both cases is 15 min. (2) The mean linear distance of two oscillating regions is about 6'' and is slightly less in active regions (10 to 20%). Neglecting the weakest oscillations, a distance of 9'' is obtained. (3) The oscillations begin and end with small amplitudes, and a maximum is reached only after some periods. In no case was an "onset" of an oscillation with maximum amplitude observed. It is suggested that the photospheric oscillations are not so much based on the excitation by single overshooting granules, as on mutual disturbance or interference of standing waves, propagating horizontally with about 6 km/sec. (4) The mean peak-to-peak amplitude of single oscillations decreases from about 600 m/sec in flux-free regions to <400 m/sec in regions with 100 gauss and more. (5) Structures with stronger fields and preferentially downward motions coincide with the borders of supergranular cells. (auth)

883 INFLUENCE OF DISSIPATION ON THE TEMPERATURE OF THE LOW CHROMOSPHERE. Frisch, Helene (Observatoire de Paris, Meudon, France. Columbia Univ., New York). Compt. Rend., Ser. A and B, 264: 1768-71(June 19, 1967). (In French).

The influence of chromospheric height on the temperature of dissipation of acoustic waves was studied by taking into consideration variations to the local thermodynamic equilibrium in the ionization of H and H^-. The massive dissipation rate given by Osterbrock is without doubt too large by a factor of 10 between 0 and 300 km but seems to be suitable toward 1,000 km. (tr-auth)

884 ON THE DOME FORMATION IN THE CORONA AROUND A PROMINENCE OBSERVED AT THE TOTAL ECLIPSE OF FEBRUARY 15, 1961. Kawaguchi, Ichiro Solar Phys., 1: 420-36(June 1967).

A conspicuous coronal dome formation around a prominence was photographed during the eclipse of February 15, 1961, with the 120-cm reflector of the Haute Provence Observatory with an excellent image definition. A detailed isophotic map of the dome formation was constructed after estimating a calibration curve. The bright dome is interpreted as an aggregate of free electrons trapped in a gigantic bundle of magnetic lines of force. The free electrons are concentrated in the central part and the degree of concentration seems to be the least at the top of dome and to increase with decreasing height. The bright dome surrounds a dark one. The minimum extension of the dark dome formation along the line of sight is estimated. It seems that the density of coronal matter is much reduced around the prominence compared with the overall coronal density. (auth)

885 A HIGH-RESOLUTION 2800-MHz MULTI-ELEMENT INTERFEROMETER. Covington, A. E.; Legg, T. H.; Bell, M. B. (National Research Council, Ottawa). Solar Phys., 1: 465-73 (June 1967).

The design of the east–west arm of a multi-element interferometer for solar noise observations in the band 2650 to 2950 MHz at the Algonquin Radio Observatory, Lake Traverse, Ont., Canada, is outlined. The completed first stage consists of an array of thirty-two 3-meter reflectors extending over 212 meters. In the scond stage, four reflectors will be arranged symmetrically about the array for polarization studies, while in the third stage four additional reflectors will be placed to the East to form a compound interferometer. These configurations provide single lobed fan beams with half power widths of 1.5, 0.5, and 0.25° of arc respectively. Scans of the sun taken on April 26th, 1966, with the 32-element array located two widely separated enhancements of radio emission, which produced a small gradual rise and fall burst on the solar patrol record. (auth)

886 EXTRA-ATMOSPHERIC OBSERVATIONS OF THE ULTRAVIOLET RADIATION IN THE WINTER MILKY WAY. Viton, Maurice (Laboratoire d'Astronomie Spatiale, Marseille). Compt. Rend., Ser. A and B, 264: 1761-4(June 19, 1967). (In French).

Three large nebulosities (apparent diameter ~10.15 to 20°)

around Sirius and in the constallations of Orion, Gemini, and Auriga were detected in the ultraviolet at 2,000 to 3,000 Å. Ultraviolet radiation of the O and B stars was also detected. (tr-auth)

887 SMALL-SCALE SOLAR MAGNETIC FIELDS AND INVISIBLE SUNSPOTS. Zwaan, Cornelis (Sacramento Peak Observatory, N. Mex.). Solar Phys., 1: 478-80(June 1967).

It has been recently found that magnetic fields of several hundred gauss occur in tiny areas as small as 500 km in extent in regions well removed from visible sunspots. The regions correspond to regions of bright CaII K_{2v} emission. It is shown that the occurrence of strong, small-scale magnetic fields may be explained in a way similar to the explanation of the stability of visible sunspots. (W.D.M.)

888 OCCULTATION OF A NOISE STORM SOURCE DURING THE PARTIAL SOLAR ECLIPSE OF MAY 20, 1966. Letfus, V.; Tlamicha, A.; Valnicek, B. (Astronomical Inst., Ondrejov, Czechoslovakia). Solar Phys., 1: 474-7(June 1967).

From the morning of the eclipse day a radio noise storm was recorded on the frequency 260 MHz. During the second half of the eclipse, shortly after the maximum phase, an interesting phenomenon was observed. The noise storm disappeared for about a half-hour. By combining the observation with those of Nera and Potsdam a possibility of determining the size and the location of the noise storm source was realized. (W.D.M.)

889 ELECTRONS >40 keV AND PROTONS >500 keV OF SOLAR ORIGIN. Lin, R. P.; Anderson, K. A. (Univ. of California, Berkeley). Solar Phys., 1: 446-64(June 1967).

Following many solar flares, electrons with kinetic energy >40 keV appear in interplanetary space. There are two classes of such electrons: prompt electrons which arrive within an hour of the flare and delayed electrons which arrive about a day following the flare. The promptly arriving electrons are found to be of two types: Simple (S) events are associated with solar flares which occur in the absence of large area type-I radio noise storm and the complex (C) events resulting from flares beneath these large radio noise regions. The propagation of energetic solar flare electrons to the earth is best described in terms of cones of propagation. In the S events the cones have about 30° opening angle whereas in the C-type events the cones open to about 90° full angle. Outside the boundaries of these cones the electron flux is much reduced. Within the cones there is a net streaming of the electrons away from the sun. Solar flare electron fluxes do not show filamentary structure even at times when protons from the same flare do. This suggests that the electrons are injected into the interplanetary field from regions distinct from the proton injection region. The delayed solar electron events are accompanied by large fluxes of protons >500 keV. These events are sometimes closely related to a sudden commencement. (auth)

890 SOLAR SOURCE OF THE INTERPLANETARY SECTOR STRUCTURE. Wilcox, John M. (Univ. of California, Berkeley); Ness, Norman F. Solar Phys., 1: 437-45(June 1967).

The interplanetary sector structure observed by the IMP-1 satellite during three solar rotations in 1963–4 is compared with the photospheric magnetic field structure observed with the solar magnetograph at Mt. Wilson Observatory. The interplanetary sector structure was most prominent on the Sun in latitudes between 10 and 20°N, although the average heliographic latitude of the satellite was 3½°S. A superposed-epoch analysis of the calcium plage structure obtained from the Fraunhofer Institute daily maps of the Sun is used to discuss the relation between the structure of the plages and the interplanetary sector structure. A possible explanation for the observations is discussed in terms of a north–south asymmetry in the flow of the solar wind. It is suggested that these observations favor the "equinoctial" hypothesis as compared with the "axial" hypothesis for the explanation of the semi-annual maxima in geomagnetic activity. (auth)

891 STELLAR AND SOLAR FLARES. Schatzman, E. (Institut d'Astrophysique, Paris). Solar Phys., 1: 411-19 (June 1967).

Some ideas are developed concerning solar flares which have been presented earlier by the author (Schatzman, 1966a). Emphasis is laid on the problem of energy transport; from the energy supply to the region of the optical flare, on the storage of low energy cosmic-ray particles in a magnetic bottle before the beginning of the optical flare, and the mechanism which triggers both the optical flare, and the production of high-energy cosmic rays. The relation between solar and stellar flares is considered. (auth)

892 FLARE OF IMPORTANCE 2 ON OCTOBER 4, 1965. Banos, G. (Observatorie de Paris, Meudon, France). Solar Phys., 1: 397-410(June 1967). (In French).

A flare of importance 2 was observed on October 4, 1965, at the Meudon Observatory with a new heliograph, which collects automatically photographs in the center and the wings (±0.7 Å) of the Hα line. The phenomena recorded in Hα are studied in relation with the longitudinal magnetic field of the associated active region. (auth)

893 PECULIAR SODIUM FLARE ON THE SUN. Gurtovenko, E. A. (Main Astronomical Observatory, Kiev). Solar Phys., 1: 389-96(June 1967).

A peculiar brightening was observed near the center of the D_2 line of NaI on July 28, 1966, in a position where no activity could be seen in the Hα line but where a new important active region formed during the next rotation of the Sun. The brightening, first observed at 06:30 UT, progressively faded and disappeared before 07:10 UT. (auth)

894 ELECTRICAL CONDUCTIVITY GRADIENTS IN SUNSPOTS. Altschuler, Martin D. (High Altitude Observatory, Boulder, Colo.). Solar Phys., 1: 377-88(June 1967).

Recently Schroeter showed that the electric conductivity of the sunspot umbra, at least in the upper photospheric layers, is about ten-thousand times less than the value used by Cowling. This result implies that electric conductivity gradients near sunspots may be relatively large. Upon taking such gradients into consideration, it is found that the photosphere is current free and that current rings might encircle the sunspot, under suitable conditions, both in the lower photosphere and in the chromosphere. Plasma motions are neglected in the calculation. (auth)

895 MAGNETIC FIELDS IN SMALL AND YOUNG SUNSPOTS. Bumba, V. (Astronomical Inst., Ondrejov, Czechoslovakia. Kitt Peak National Observatory, Tucson, Ariz.). Solar Phys., 1: 371-6(June 1967).

Preliminary results of magnetic field measurements in small sunspots from spectrograms obtained with the aid of the McMath Solar Telescope at the Kitt Peak National Observatory are presented. The measured intensities are greater than or equal to about 1200 gauss. Furthermore, a broadening of the Fe I line λ6302.508 Å was found in some places of intergranular space. The importance of intergranular space as a possible potential earliest stage of sunspot development is mentioned. (auth)

896 ORIGIN OF SPICULES IN THE CHROMOSPHERE–CORONA TRANSITION REGION. Kuperus, Max; Athay, R. Grant (High Altitude Observatory, Boulder, Colo.). Solar Phys., 1: 361-70(June 1967).

Qualitative arguments are presented to show that in the chromosphere–corona transition region the energy which is transported downwards by heat conduction cannot be disposed of by radiative losses only. The region therefore is unstable and forced to be in motion, which may give rise to spicule-like phenomena. (auth)

897 INFLUENCE OF DOUBLY EXCITED LEVELS ON THE IONIZATION FORMULA FOR THE SOLAR CORONA. Van Rensbergen, Walter (Space Research Lab., Utrecht). Solar Phys., 1: 354-60(June 1967).

The existence of doubly excited levels causes dielectronic recombination and autoionization. These effects influence respectively the total recombination rate and the total ionization rate of different ions. The ratios of dielectronic recombination to radiative recombination and of autoionization to collisional ionization are given as a function of the electron temperature for the term systems of (O(IV), O(V), O(VI), Si(IX), and Fe(XV). While autoionization can contribute appreciably to the total ionization rate, dielectronic recombination is always the most effective recombination mechanism. (auth)

898 THEORY OF SOLAR BURSTS. Takakura, Tatsuo (Tokyo Univ.). Solar Phys., 1: 304-53(June 1967).

An attempt is made to review the current theories and models of solar bursts in order to show the extent to which the theories contribute towards the interpretation of the nature of the bursts. (W.D.M.)

899 POSSIBLE CIRCULAR POLARISATION OF COMPACT QUASARS. Sciama, D. W.; Rees, M. J. (Cambridge Univ., Eng.). Nature (London), 216: 147(Oct. 14, 1967).

The possibility that the radio and optical radiation from compact quasars may be circularly polarised is discussed, including situations in which this polarisation is most likely to be detectable. Theoretical implications are also discussed. In a typical radio galaxy, with H ~10^{-5} gauss, an unobservably small amount of circular polarisation would be expected. The percentage of polarization may, however, be much larger for compact quasars, the magnetic field of which may be as great as 1 to 100 gauss. The radiation from these objects at, say, ~3,000 Mc could, in theory, be 3 to 30% circularly polarised. The observed net polarisation would, however, be reduced for three reasons: (a) the

magnetic field in the compact component might be non-uniform; (b) synchrotron self-absorption would destroy circular polarisation within the compact component if the optical depth were large; (c) a contribution to the flux might come from a non-varying "halo" with a weaker magnetic field. These factors are discussed. It is concluded that the existence of at least 1% circular polarisation in the radio emission from compact quasars is by no means unlikely. The chances of detecting it would be greatest if observations were made at a frequency where large amplitude intensity variations are known to occur (≳1,000 Mc), at a time when the flux is just starting to decrease. If circular polarisation were observed it would provide evidence for operation of the synchrotron process, and enable direct estimation of the magnetic field strength. It is noted that the optical continuum would not be circularly polarised if it is the result of synchrotron emission, but there is the alternative possibility that the optical continuum results from inverse Compton scattering of radio synchrotron radiation, which may possess significant circular polarisation. (UK)

900 POSSIBLE INSTABILITY IN THE SELF-CLOSURE PHENOMENON IN GRAVITATIONAL COLLAPSE. Israel, W. (Dublin Inst. for Advanced Studies). Nature (London), 216: 148-9(Oct. 14, 1967).

Present ideas on the nature of relativistic collapse are largely derived from study of spherisymmetric models. The most striking feature of spherical collapse—the formation of a critical surface ("event horizon"), characterised by infinite gravitational redshift, which divorces the collapsing object from the external observer—is believed to typify realistic situations, at least if the asymmetries are not too large. The purpose of the present communication is to point out that models with exact spherical symmetry possess idiosyncrasies which render them dangerous, and perhaps misleading, as a basis for induction. The work of Regge and Wheeler on the analysis of small perturbations of Schwarzchild's spherically symmetric field of a point mass is discussed, and the collapse of an asymmetric (non-rotating) star is considered, on the assumption that an "event horizon" is formed. There are two possibilities, the first being that the star shakes off its quadrupole and higher moments and is "patted" into spherical shape before crossing the "event horizon." The second possibility is that the "event horizon" becomes smudged out and obliterated. These possibilities are discussed. (UK)

901 INERTIAL CONFINEMENT OF EXTENDED RADIO SOURCES. DeYoung, David S. (Cornell Univ., Ithaca, N. Y.); Axford, W. I. Nature (London), 216: 129-31(Oct. 14, 1967).

The confinement of extended radio sources is discussed, and it is suggested that this may be a dynamic rather than a static process where the internal pressure of the source is balanced by the ram pressure of the intergalactic gas. (auth) (UK)

902 NORMAL MODES OF VIBRATIONS OF THE UNIVERSE. Harrison, E. R. (Univ. of Massachusetts, Amherst). Rev. Mod. Phys., 39: 862-82(Oct. 1967).

Some aspects of our knowledge of the gravitational theory of fluctuations of density in homogeneous and isotropic models of the Universe are reviewed. Irrotational fluid motions only are considered. All perturbations are assumed to be small and a normal mode analysis is used. The nature and time dependence of the amplitude of the various modes in expanding and contracting models of the Universe are considered within the framework of Newtonian and general relativity theories. The origin of celestial structure requires that a uniform Universe is unstable against arbitrarily small perturbations. However, the rate of growth of the allowed modes, particularly in an expanding Universe, is sufficiently slow to cast doubt on the instability of the models. (auth)

903 MEAN SPECTRUM AND ABSOLUTE MAGNITUDE OF QUASI-STELLAR OBJECTS. Hameen-Anttila, K. A.; Jaakkola, Toivo (Univ. of Oulu, Finland). Ann. Acad. Sci. Fenn., Ser. A VI, No. 246, 1-11(1967).

The smoothed mean spectrum of quasars is corrected for interstellar absorption. This leads to new values of K corrections. As an application, the absolute visual magnitude −22.5 is derived for these objects from their magnitude−redshift relation. The gravitational redshift is found to be significant for the nearest objects. (auth)

904 RADIO ASTRONOMY: A LARGE ANTENNA ARRAY. Heeschen, D. S. (National Radio Astronomy Observatory, Green Bank, W. Va.). Science, 158: 75-8(Oct. 6, 1967).

The NRAO has designed a very large array (VLA) of radio telescopes. The VLA will consist of 36 parabolic antennas operated synchronously to produce radio maps with 1 second of arc resolutions. The principal characteristics of the VLA are discussed in terms of wavelength, resolution, side-lobe levels, sensitivity, time required for an observation, polarization, sky coverage, spectral line observations, and flexibility. (W.D.M.)

905 MARTIAN IONOSPHERE: A COMPONENT DUE TO SOLAR PROTONS. Sagan, Carl; Veverka, Joseph (Harvard Univ., Cambridge, Mass. Smithsonian Astrophysical Observatory, Cambridge, Mass.). Science, 158: 110-12(Oct. 6, 1967).

The small magnetic field strength observed near Mars by Mariner IV suggests that protons from the solar wind may enter the Martian atmosphere and produce ionization in addition to that produced by ultraviolet light and x rays. It is found that solar protons produce a thin ionized layer at a rate of the order of $3 \times 10^3/cm^3/sec$ at a depth corresponding to the F1 region in the terrestrial atmosphere. Unless the effective recombinative coefficient is very large (greater than 10^{-5} centimeter cubed per second) or unless unusual diffusion effects are present, this layer should have been detected by Mariner IV, and therefore must be present in one of the observed ionized regions. Because of its very compact shape, the subsidiary maximum near 95 kilometers discovered in the Mariner-IV occultation experiment may be the proton ionization peak. If so, the major 120-km maximum is an F2 layer. Distinction between photon and proton ionization regions can be made by microwave occultation experiments aboard planetary orbiters. (auth)

906 APPLICATION OF THE HYPERSONIC ANALOG TO THE STANDING SHOCK OF MARS. Dryer, Murray; Heckman, Gary R. (Inst. for Telecommunication Sciences and Aeronomy, Boulder, Colo.). Solar Phys., 2: 112-24(July 1967).

A magnetospheric boundary and its associated standing-shock wave for the Earth are scaled down in size to apply to Mars. A suggestion by the Mariner-IV experimenters that their magnetometer may have detected a Martian shock at 0123 UT (earth) on July 15, 1965, is accepted. The scaling procedure used previously in the case of the Mariner-II flyby of Venus on December 14, 1962, as well as in the present case of Mars is repeated but with a different model. A magnetospheric boundary for the earth is proposed, which is based on a maximum radius of 22 R_E suggested by Imp-1 magnetometer data, and a low value (1.2) of the adiabatic exponent, γ, is suggested. In addition the use of the interplanetary magnetoacoustic Mach number, M_{ms}, which is a combination of both Alfvén and ordinary gasdynamic Mach numbers is proposed. The choice of values for these parameters is not unique since many such combinations exist which will show good agreement with observation. For example, the ratio of the Martian dipole moment to that for the earth is found to be 2.1×10^{-4} by application of the hypersonic analog. This value compares very closely with 3×10^{-4} deduced as an upper bound by the Mariner-IV investigators. The present synthesis is presented as an independent calculation based on the above theoretical considerations, together with the experimenters' probable observation of a Martian shock wave. (auth)

907 DETERMINATION OF THE SOLAR X-RAY SPECTRUM BY USING THE ATMOSPHERIC EXTINCTION. Landini, M. Solar Phys., 2: 106-11(July 1967).

Indications about the spectral distribution of the solar radiation below 20Å are obtained by comparing the atmospheric extinction of the solar radiation measured by three ion chambers in the satellites SOLRAD 7 and 8. The data refer to July 5, 6, and 8, 1965 and July 23, 1966 when the satellites passed from light to darkness into or out of the earth's shadow. The spectral intensity distribution is shown for the four days, and a comparison is made between active and quiet days. (auth)

908 COMMENTS ON A FLARE OF SEPTEMBER 20, 1966. Tandberg-Hanssen, Einar (High Altitude Observatory, Boulder, Colo.). Solar Phys., 2: 98-105(July 1967).

On Sept. 20, 1966, around 1800 UT, a flare occurred in active region McMath plage number 8505 just west of the central meridian. The flare started as a bright knot over the umbra of the largest spot of the active region. During the activity, filtergrams, spectra, and magnetograph observations were secured of the flaring region. The observations are reported and some aspects of this flare phenomenon are discussed. (W.D.M.)

909 ELECTRON DENSITY IN FLARES. II. RESULTS OF MEASUREMENT. Fritzova-Svestkova, L.; Svestka, Z. (Astronomical Inst. of the Czechoslovak Academy of Sciences, Ondrejov). Solar Phys., 2: 87-97(July 1967).

Measurements of the electron density in 16 flares are summarized and discussed. For 13 of them the electron density was determined by the halfwidth method discussed in Part I. In the flash phase of all disk flares of importance 1+ and higher the electron density exceeds $10^{13} cm^{-3}$ and increases with the flare importance. In the maximum of large flares the electron density

exceeds $3 \times 10^{13}cm^{-3}$ and declines to $10^{13}cm^{-3}$ and to lower values in about 20 minutes after the flash phase. In limb flares, i.e., higher than 5000 km above the solar limb, the electron density is lower than $5 \times 10^{12}cm^{-3}$. This shows a decrease of the electron density in the flare elements situated in higher parts of the chromosphere. On the other hand, however, at least in some flares the electron density remains fairly constant within a wide range of height in the upper chromosphere and the low corona. (auth)

910 ELECTRON DENSITY IN FLARES. I. DISCUSSION OF THE HALFWIDTH METHOD. Svestka, Z.; Fritzova-Svestkova, L. (Astronomical Inst. of the Czechoslovak Academy of Sciences, Ondrejov). Solar Phys., 2: 75-86(July 1967).

The halfwidth method used for the determination of the electron density in flares is discussed from the point of view of possible errors which may enter the obtained results. The discussion includes an analysis of errors of measurement as well as errors of the method due to: (1) incomplete knowledge of the electron damping, (2) the assumption of constant electron temperature, (3) the presence of residual self-absorption in high Balmer lines, and (4) possibly present nonthermal motions. It is shown that the factors (2) to (4) cannot induce any relative error in n_e higher than 30% of the correct value, and the actual error usually is smaller. A comparison is made of the halfwidth method application to active prominences and limb flares. (auth)

911 A PHENOMENOLOGICAL MODEL FOR DISPARITIONS BRUSQUES FOLLOWED BY FLARELIKE CHROMOSPHERIC BRIGHTENINGS. I. THE MODEL, ITS CONSEQUENCES, AND OBSERVATIONS IN QUIET SOLAR REGIONS. Hyder, Charles L. (Air Force Cambridge Research Labs., Sunspot, N. Mex.). Solar Phys., 2: 49-74(July 1967).

A simple gravitational model is presented for the flarelike brightenings of the chromosphere that follow most disappearing filaments. It is assumed that the ascending prominence material is lifted out of the initially stable magnetic dips that characterize quiescent prominences and falls along the arched field lines into the chromosphere where the kinetic energy of fall is dissipated in the bright areas. The examination of prominence and chromospheric characteristics leads naturally to many predictions and relations during and after prominence eruptions. In general the predictions are specific, but the observations of necessary detail and quality are nonexistent; however, the predictions appear to agree with the data that are available. The model appears to explain all non-active-region brightenings of the chromosphere that follow disappearing filaments and an unknown fraction of active-region flares. The conclusion is that two-ribbon flares are due to the disappearing filaments → chromospheric flarelike brightening mechanism. It is clear that many specific observations in and out of active regions will be necessary to test the predictions of the model given here. (auth)

912 NATURE OF QUIESCENT SOLAR PROMINENCES. Kuperus, Max; Tandberg-Hanssen, Einar (High Altitude Observatory, Boulder, Colo.). Solar Phys., 2: 39-48(July 1967).

Quiescent prominences occur as long-lasting cool sheets of matter in the surrounding hot corona at the base of coronal streamers. Seen on the disk they appear as dark filaments dividing regions of opposite magnetic polarity. A theoretical model is presented, which describes the general appearance of quiescent prominences. It is shown that the neutral sheet between two regions of oppositely directed magnetic fields is thermally unstable. This gives rise to compression and cooling of coronal material to prominence material in a characteristic time of the order of one day for a field strength of 0.5 gauss in the lower corona. It is assumed that due to the finite electrical resistivity of the plasma, filamentary structures are formed by the 'tearing-mode' resistive plasma instability. These structures are thermally insulated from the hot surroundings by the newly formed closed azimuthal magnetic field configuration. It has been shown that for fine structures with a diameter of 300 km the growth rate of the 'tearing-mode' instability is of the same order as the cooling time. The occurrence of fine structures within the prominence is of vital importance for their origin. (auth)

913 FORBIDDEN CARBON I LINES IN SOLAR SPECTRUM. Lambert, D. L. (Univ. Observatory, Oxford); Swings, J. P. Solar Phys., 2: 34-8(July 1967).

The strongest CI line is present in the solar spectrum at the predicted wavelength of λ 8727.13 Å. This is the first identification of a CI line in an astrophysical source. Its equivalent width agrees with a carbon abundance similar to that developed by Goldberg–Müller–Aller and corrected by Zwaan: this is consistent with assumption of LTE in the solar photosphere, at least as far as the Boltzmann equation is concerned. The considerably weaker line at λ 4621.57 Å is probably present. λλ 9850.25 and 9824.12 Å seem too weak to be detected at the present time. (auth)

914 VELOCITY FIELDS IN THE SOLAR ATMOSPHERE. Howard, Robert (Carnegie Inst. of Washington, D. C. California Inst. of Tech., Pasadena). Solar Phys., 2: 3-33(July 1967).

Observations of velocity fields in the solar atmosphere made with the Mount Wilson solar magnetograph are analyzed. These observations, which were made with very high velocity sensitivity, cover nearly 250 hours and were made with apertures of several sizes and at various parts of the solar disk, and in strong and weak magnetic fields. The amplitudes of the 300-sec oscillations are about 25% weaker in regions where the magnetic field is greater than 80 gauss than where the field is less than 10 gauss. No difference in the frequencies of the oscillations could be found between strong-field and field-free regions. It is suggested that the oscillations occur only where the field is absent and the lower amplitude in a strong field represents the fraction of the magnetograph aperture occupied by a magnetic field. The element sizes for the 300-sec oscillations are probably at least 5 to 10 arc seconds. Observations made simultaneously with two lines formed at different depths in the solar atmosphere showed small phase differences in the 5-min oscillations. The upper level showed shorter period oscillations when the lower level oscillations underwent phase changes. A short period oscillation is found superposed on the 300-sec oscillation. These SPOs come in bursts that last for a minute or two and have average amplitudes that fall in the range 0.05 to 0.10 km/sec peak to peak. All attempts to explain them as instrumental or seeing effects have failed. Their periods fall in the range 1 to 5 seconds. The horizontal scale of these oscillations is smaller than that of the 300-sec oscillations, and the SPOs are more nearly isotropic oscillations than are these around 300 seconds. They do not represent a high-frequency tail of the latter. These observations did not have a digitizing interval short enough to analyze the SPOs for power spectra, but it is clear from the tracings that they are not a nearly monochromatic oscillation as are the longer waves. The amplitudes of the SPOs in the solar atmosphere must be very large and they contribute greatly to the nonradiative energy flux. It is suggested that they represent a large 'microturbulence' line-broadening effect. (auth)

915 ABUNDANCE ANOMALIES PRODUCED BY NUCLEAR REACTIONS IN STELLAR SURFACE LAYERS. II. RESULTS AND COMPARISON WITH ANOMALIES IN PECULIAR A STARS. Brancazion, P. J. (City Univ. of New York. Yeshiva Univ., New York. Goddard Space Flight Center, Greenbelt, Md.); Cameron, A. G. W. Can. J. Phys., 45: 3297-312(Oct. 1967).

A normal solar abundance distribution of the elements was subjected to a calculated bombardment by protons and alpha particles having energy spectra of the form E^{-n}, where n was usually taken to be equal to 2.5, and having low-energy cutoffs on the spectra at 1 MeV. Bombardment with protons resulted in breakdown of nuclei to lower mass numbers. Bombardment with alpha particles resulted in buildup of nuclei to higher mass numbers. It is concluded that preferential acceleration of alpha particles to varying total fluxes can produce the abundance anomalies of peculiar A stars in concentrated patches on the surface. Local surface magnetic fields in the range 10^6 to 10^7 G are required to provide the necessary energy sources for the accelerated particles. (auth) (CANADA)

916 HIGH-ENERGY ASTROPHYSICS. Course XXXV of Proceedings of the International School of Physics "Enrico Fermi," Varenna, Italy, July 12-24, 1965. Gratton, L. (ed.). New York and London, Academic Press, 1966. 474p. $23.00; 184s.

The Chapters include discussions of quasars, radio galaxies, x-ray and γ-ray sources, the neutron star hypothesis, supermassive stars, and the cosmological aspects of high-energy astrophysics. Separate abstracts were prepared for the twelve chapters. (W.D.M.)

For abstracts of individual chapters see: 917–927 and 1469.

917 HIGH-ENERGY ASTROPHYSICS. Gratton, L. (Univ., Rome. CNR, Rome). pp 1-9 of High-Energy Astrophysics. Gratton, L. (ed.). New York and London, Academic Press, 1966.

High-energy astrophysics is given as a title to those developments in which the rate of energy release per second and gram is very high as compared with those of more usual processes going on in normal stars and galaxies. The problems of interpretation in the processes going on in supernovae, neutron stars, gravitational collapse, radio galaxies, quasars, and related objects are briefly mentioned. (W.D.M.)

918 OBSERVATIONAL PROPERTIES OF RADIO GALAXIES AND QUASI-STELLAR SOURCES. Sandage, A. (Carnegie Institution of Washington, Washington, D. C. California Inst. of Tech., Pasadena). pp 10-42 of High-Energy Astrophy-

sics. Gratton, L. (ed.). New York and London, Academic Press, 1966.

The history of radio galaxies and quasars is traced from the first discovery of discrete sources, through the intense cataloging phases and early optical identifications, to the discovery of quasars, and finally to the use of these data in cosmology. (W.D.M.)

919 RADIO GALAXIES AND QUASI-STELLAR RADIO SOURCES. Burbidge, E. M. (Univ. of California, San Diego). pp 43-72 of High-Energy Astrophysics. Gratton, L. (ed.). New York and London, Academic Press, 1966.

An attempt is made to make deductions about radio galaxies and quasars from their optical spectra, discussing particularly the physical conditions (temperature, density, and source of ionization of the gaseous component) and the kinematics of the constituent parts of radio galaxies. The properties of radio galaxies are related to the normal galaxies on the one hand, and to the quasars on the other hand, and also to various theories that have been put forward to explain the source of the large energies needed to account for the radio emission. (W.D.M.)

920 SOME OBSERVATIONAL ASPECTS OF X-RAY ASTRONOMY. Giacconi, R. (American Science and Engineering, Inc., Cambridge, Mass.); Gursky, H.; Waters, J. R.; Rossi, B.; Clark, G.; Garmire, G.; Oda, M.; Wada, M. pp 73-114 of High-Energy Astrophysics. Gratton, L. (ed.). New York and London, Academic Press, 1966.

Instrumentation for observing x-ray sources is discussed briefly including x-ray detectors, collimators, image-forming telescopes, and optical sensors. Analysis problems relative to rocket observations is reviewed in terms of frames of reference and freely spinning rockets. Observational results are given for the Crab Nebula, sources near the galactic center, and other sources. Spectral information and flux estimates are included. (W.D.M.)

921 X-RAY AND γ-RAY SOURCES. Burbidge, G. (Univ. of California, San Diego). pp 114-65 of High-Energy Astrophysics. Gratton, L. (ed.). New York and London, Academic Press, 1966.

The theoretical side of x-ray and gamma-ray astronomy is considered. The basic processes which can be expected to give rise to x-ray and γ-ray fluxes is discussed and are related to the observational results. Most of the photon-producing processes are treated where the effects of high-energy electrons produced in cosmic-ray nuclear collisions are considered. The problem of discrete sources of x rays and the possibility of observing extragalactic sources of high-energy photons are taken up. (W.D.M.)

922 GENERAL-RELATIVISTIC THEORY OF STELLAR STRUCTURE AND DYNAMICS. Thorne, K. S. (Princeton Univ., N. J.). pp 166-280 of High-Energy Astrophysics. Gratton, L. (ed.). New York and London, Academic Press, 1966.

The basic thermodynamic and gravitational concepts upon which the subsequent discussions are based are presented. A derivation and discussion of the general relativistic equations of stellar structure are given, together with delineations and proofs of some fundamental properties of relativistic stellar models. The theory of the dynamical stability of relativistic stellar models is developed. These models are applied to configurations of matter near the endpoint of thermonuclear evolution and to a wide class of hot, nondegenerate stellar models. A brief introduction is given to the theory of gravitational collapse to zero volume and infinite density. (W.D.M.)

923 PROPERTIES OF COLD DENSE MATTER. Szamosi, G. (Univ. of Windsor, Ont.). pp 281-301 of High-Energy Astrophysics. Gratton, L. (ed.). New York and London, Academic Press, 1966.

Ambartsumyan has been led to work out a simple theory of the chemical composition of cold dense matter. This analysis in a somewhat more up-to-date form is the subject of the first part of this lecture. In the second part some of the attempts which have been made to establish an equation of state for cold dense matter are reviewed. The equation of state enables one to discuss the question of the gravitational collapse and stability both in Newtonian and Einsteinian gravitation, and it is also relevant to the cooling problem of neutron stars. (W.D.M.)

924 PRESENT STATUS OF THE NEUTRON-STAR HYPOTHESIS. Finzi, A. (CNR, Frascati, Italy). pp 302-12 of High-Energy Astrophysics. Gratton, L. (ed.). New York and London, Academic Press, 1966.

The question of the observability of neutron stars and the recent attempts to confirm the old hypothesis of the formation of neutron stars in type-I supernova outbursts are considered. (W.D.M.)

925 SUPERMASSIVE STARS, QUASARS, AND EXTRAGALACTIC RADIO SOURCES. Fowler, W. A. (California Inst. of Tech., Pasadena). pp 313-66 of High-Energy Astrophysics. Gratton, L. (ed.). New York and London, Academic Press, 1966.

The purpose of this lecture is, first, to discuss the observational work which makes possible the identification of radio sources with optical objects observable through large telescopes, and to consider various suggestions which have been made concerning the source of the prodigious energies involved in the radio objects. Topics discussed include optical identification of radio sources, energy requirements of the sources, supermassive stars, quasars, relaxation oscillations in nonrotating supermassive stars, rotation and stability of supermassive stars, binding energy of a supermassive star in hydrostatic equilibrium, equation of dynamic equilibrium, adiabatic radial pulsation, applications to polytropic models, rotational stability versus general relativistic instability, the limit of rotational stability, and dynamic and rotational periods. (W.D.M.)

926 NEUTRINO ASTROPHYSICS. Fowler, W. A. (California Inst. of Tech., Pasadena). pp 367-99 of High-Energy Astrophysics. Gratton, L. (ed.). New York and London, Academic Press, 1966.

This lecture covers solar, stellar, galactic, and extragalactic neutrino astrophysics. The general theme is the estimation of the quantity E_ν defined as energy emitted as ν or $\bar{\nu}$ divided by the rest mass–energy of the emitting system. This quantity has obvious cosmological implications and on conservation estimates is usually $\sim 10^{-4}$. Topics covered include significance of neutrino detection, neutrino emission by the Sun, detection of solar neutrinos, observational techniques, and theoretical problems concerning neutrino astrophysics. (W.D.M.)

927 COSMOLOGICAL ASPECTS OF HIGH-ENERGY ASTROPHYSICS. Sciama, D. W. (Cambridge Univ., Eng.). pp 418-63 of High-Energy Astrophysics. Gratton, L. (ed.). New York and London, Academic Press, 1966.

Topics discussed include Mach's principle and the physical foundations of general relativity, physical conditions in intergalactic space, radio variables and their cosmological significance, and the interpretation of the radio source counts. (W.D.M.)

Atomic and Molecular Physics

Refer to abstracts 395, 943, 1312, 1350, 1351, and 1442.

928 (AGARD-CP-12(Vol.1)) RECENT ADVANCES IN AEROTHERMOCHEMISTRY. A Selection of Technical Papers from the 7th AGARD Colloquium, Oslo, Norway, May 16–20, 1966. Glassman, I. (ed.) (Advisory Group for Aerospace Research and Development, Paris (France)). 1967. 442p. (CONF-660569-(Vol.1)).

Separate abstracts were prepared for ten of the seventeen papers included. The papers not abstracted deal with theoretical and experimental approaches to chemical rate processes in fluids with particular emphasis on the dissociation and recombination of small molecules and on vibrational relaxation. (A.G.W.)

For abstracts of individual papers see: 929–938.

929 (AGARD-CP-12(Vol.1), pp 147-64) ROLE OF VIBRATIONAL EXCITATION IN ATOM SWITCHING REACTIONS. Bauer, S. H. (Cornell Univ., Ithaca, N. Y.).

The atom switching reaction, HX + DY → HY → DX, has been presumed to occur via a direct bimolecular process involving a 4-center transition state. Classical statistical mechanics, which incorporates the assumptions that Boltzmann populations are essentially maintained for all states and that equipartition holds, leads to a pre-exponential factor of the form $(1/s!)(\epsilon/kT)^2$; rough quantum mechanics calculations indicate an activation energy $\epsilon \simeq 60$ kcal/mole. The data obtained from the shock tube measurements of D/H exchange rates between D_2 and CH_4, NH_3, H_2S, HCl, and H_2 are in disagreement with both predictions. Shock tube techniques proved essential. Only by means of such a gas dynamic process can a sample of gas be heated sufficiently rapidly and homogeneously so that one may separate in time the successive flow of energy from translation and rotation to vibrations and eventually produce chemical changes. The analytic results show that not only are there restrictions on the relative efficiency of utilizing the energy associated with the different molecular degrees of freedom, but also that the relative kinetic energy of translation plays practically no role; the vibrational energy of D_2 dominates the rate of exchange. Several predictions based on this mechanism are being investigated; partial verifications have been obtained. (auth)

930 (AGARD-CP-12(Vol.1), pp 191-216) MODULATED ATOMIC BEAMS AND THEIR USES. Fite, Wade L. (Pittsburgh Univ., Pa. Dept. of Physics).

The principal features of modulation techniques as applied to atomic and molecular beam experimentation are first discussed, with particular relation to problems of signal-to-noise ratio. The use of modulation beam techniques in the measurement of collision cross sections in crossed-beam experiments is then illustrated by examples of recent work on electron and ion collisions with free atoms, other free radicals, and excited atomic and molecular species. Neutral–neutral reactive collisions are also discussed briefly. The application of reflected modulated-beam techniques to study the interactions of gases with surfaces is considered, and some recent findings are briefly reviewed. (auth)

931 (AGARD-CP-12(Vol.1), pp 217-36) THERMAL ENERGY MOLECULAR BEAM MEASUREMENTS OF ATOM–ATOM DIFFERENTIAL SCATTERING CROSS SECTIONS. Pauly, Hans (Bonn Univ. (West Germany). Institut fuer Angewandte Physik).

The goal of all molecular-beam research on elastic collisions between neutral atoms or molecules is the elucidation of the interaction potential. To obtain information on the intermolecular potential from scattering experiments with molecular beams, it is necessary to first assume some analytical form of the intermolecular potential V(r). Observed and calculated differential and total collision cross sections are then compared to determine the parameters of the assumed potential. Most experiments on elastic scattering done so far have been carried out at thermal energies, where the scattering cross sections are sensitive primarily to the attractive part of the potential. They have included measurements of the long-range van der Waals potential, and the distance dependence $V(r)r^{-6}$ has been demonstrated experimentally from measurements of the differential cross section at small angles as well as from measurements of the velocity dependence of the total elastic cross section. Information obtainable from the "glory" oscillations in the velocity dependence of the total cross section and interference effects in differential cross sections (rainbow scattering) are discussed in relation to the shape of the intermolecular potential. (auth)

932 (AGARD-CP-12(Vol.1), pp 237-76) THERMAL ENERGY MOLECULAR BEAM MEASUREMENTS OF INELASTIC CROSS SECTIONS FOR ROTATIONAL QUANTUM TRANSITIONS. Toennies, J. Peter (Bonn Univ. (West Germany). Physikalisches Institut).

In recent years molecular-beam scattering experiments have been successful in measuring the differential inelastic cross sections for transitions between rotational quantum states. The molecular-beam results are reviewed and compared with theory and with the results of other less direct methods. For detecting inelastic scattering two techniques have been used. In one method the inelastically scattered particles are observed by the velocity shift resulting from the loss or gain of kinetic energy. In the other method the change in rotational state of the molecules is directly observed. The experimental techniques and the types of collision processes experimentally accessible by both methods are pointed out. The experimental results from the molecular-beam experiments and their interpretation are discussed in detail. Recent unpublished measurements of total cross sections, which provide direct information on the intermolecular potential between molecules and between molecules and atoms, are surveyed. (auth)

933 (AGARD-CP-12(Vol.1), pp 277-338) PERFORMANCE OF AN ARC-HEATED SUPERSONIC MOLECULAR BEAM AND ITS APPLICATION TO MOLECULE–MOLECULE COLLISION STUDIES. Knuth, Eldon L.; Kuluva, Neil M. (California Univ., Los Angeles).

The UCLA program directed toward production and application of intermediate-energy (1 to 10 eV) molecular beams is reviewed in some detail. Basically the beam is produced by heating the beam gas in an electric arc and then converting the energy of thermal motion into energy of directed motion in a supersonic jet. Jet production, beam collimating, speed determination, beam detection, beam-performance studies, and molecule–molecule collision studies are described. Only preliminary results have been obtained to date, but the capability of the system to produce 1-eV total-cross-section data has been demonstrated. (A.G.W.)

934 (AGARD-CP-12(Vol.1), pp 339-62) SUPERSONIC NOZZLE BEAMS: SOME RECENT EXPERIMENTAL RESULTS. Abuaf, N.; Anderson, J. B.; Andres, R. P.; Fenn, J. B. (Princeton Univ., N. J.).

The important features of nozzle beams and some results of past studies of their behavior and usefulness are reviewed briefly. Recent results at Princeton are then summarized, which indicate that aerodynamic acceleration of heavy molecules by a light gas can be used to produce high-intensity molecular beams at energies up to 10 eV and higher. (A.G.W.)

935 (AGARD-CP-12(Vol.1), pp 363-76) CHEMICAL REACTION CROSS SECTIONS DETERMINED BY MOLECULAR BEAMS IN THE 10-eV ENERGY RANGE. Utterback, Nyle G. (General Motors Corp., Santa Barbara, Calif. Defense Research Labs.).

The production of molecular beams in the 10-eV energy range by the technique of ionization by electron impact, electrostatic acceleration, and neutralization by resonant charge transfer is discussed. The application of such a beam to the determination of chemical reaction cross sections is considered in detail, particularly as to the present study of the reactions $N_2 + GO \rightarrow NO^+ + CN^-$, and $N_2(15,15) + N_2(14,14) \rightarrow N_2^+(15,14) + (N_2(15,14) + e$. Other methods for producing neutral beams in this energy range are discussed. Of particular interest is the possibility for producing beams of excited atoms and molecules. (auth)

936 (AGARD-CP-12(Vol.1), pp 377-410) THE PRODUCTION OF A 2-eV PULSED ARGON BEAM USING A SHOCK TUBE SOURCE. Jones, T. V. (Oxford Univ. (England)).

Aerodynamic beam methods used to produce a fast beam from a shock tube are discussed. The basis of the method is the continuum expansion of a gas to a high Mach number where the flow density and temperature is such that it becomes free-molecular, and subsequent collimation of the flow is used to produce a beam. A brief review of the theory of the method is followed by a description of the experimental apparatus used and a summary of results of argon studies. (A.G.W.)

937 (AGARD-CP-12(Vol.1), pp 411-22) TOTAL CROSS-SECTION MEASUREMENTS FOR K ON He IN THE ENERGY RANGE OF 0.35 TO 16.5 eV. Politiek, J.; Los, J.; Schipper, J. J. M. (Stichting voor Fundamenteel Onderzoek der Materie, Amsterdam (Netherlands). Laboratorium voor Massascheiding).

A molecular beam apparatus has been constructed, which uses the phenomenon of cathode sputtering for the production of an atom beam. A potassium target is bombarded by a 6-keV Ar^+ ion beam produced by a unoplasmatron source. By means of two slits the sputtered potassium atoms are collimated, giving a beam of atoms in the energy range of 0.35 to 16.5 eV. A 6% resolution slotted-disk velocity selector is placed between the atom source and the collision chamber. The detector is a surface-ionization platinum–tungsten wire. With this apparatus total cross sections have been measured for the system K–He in the velocity range 1400 to 9000 m/sec. The velocity dependence of the cross section interpreted as an inverse power potential dependence gives s = 11. (auth)

938 (AGARD-CP-12(Vol.1), pp 423-42) DESIGN OF EXPERIMENTS WITH A SHOCK-TUBE-DRIVEN MOLECULAR BEAM. Skinner, G. T. (Cornell Aeronautical Lab., Inc., Buffalo, N. Y.).

The work carried out during the last year with the CAL shock-tube-driven beam relates to the three main areas of application, namely, surface accommodation coefficient studies, interparticle potential (collision-cross-section) measurements, and chemical reaction sampling. Some theoretical and experimental considerations that govern the design of typical experiments are discussed. Particular examples include a theoretically attractive experiment involving the measurement of the small-angle recoil of target particles, which has some features in common with chemical sampling. Experimental problems encountered with the use of a quadrupole mass spectrometer as detector for this work are discussed. Some comments are also made on the interrelationship between analytical problems in data reduction and experimental operating conditions, as encountered in designing differential cross-section experiments. (auth)

939 (AGARD-CP-12(Vol.2)) RECENT ADVANCES IN AEROTHERMOCHEMISTRY. A Selection of Technical Papers from the 7th AGARD Colloquium, Oslo, Norway, May 16–20, 1966. Glassman, I. (ed.) (Advisory Group for Aerospace Research and Development, Paris (France)). 1967. 402p. (CONF-660569–(Vol.2)).

A separate abstract was prepared for one of twelve papers included. The other eleven papers deal with nonequilibrium flow phenomena as governed by energy transfer processes and approximate analyses to simplify the handling of nozzle flows in which complex chemical reactions take place. (A.G.W.)

For an abstract of the individual paper see: 940.

940 (AGARD-CP-12(Vol.2), pp 593-606) MASS-SPECTROMETRIC STUDIES OF IMPURITY IONIZATION IN SHOCK-HEATED ARGON. Sturtevant, B.; Wang, C. P. (California Inst. of Tech., Pasadena).

Studies of the ionization kinetics of impurities in shock-heated argon using a sampling mass spectrometer are described. The ions produced by thermal ionization in the early stages of the relaxation process behind a reflected shock wave are extracted from the shock tube through a small orifice in the end wall after they have diffused through the dense thermal layer adjacent to the wall,

and are separated and studied individually with the mass spectrometer. The ion diffusion is analyzed in detail to assess the possibility that the sampling process alters the reaction products. This mode of sampling is compared with others. It is found that in shock-heated argon contaminated with about 50 ppM of naturally occurring impurities, at temperatures of from 10,500 to 14,300°K, a surprisingly large number of different ions are produced during the initial stages of ionization, but that O^+ and H^+ predominate, each being an order of magnitude more abundant than, e.g., Ar^+. Consistent with the large rates, the ionization of H and O (which are thought to be coupled) approach equilibrium early in the relaxation process. The activation energy for ionization of H is about 10 eV and its effective cross section is about 10^3 times the inelastic cross section for argon. Measurements of the argon activation energy agree within experimental accuracy with the results of Harwell and Jahn. The kinetics of the ionization reactions are also studied with small amounts of H_2 and O_2 added to the argon. (auth)

941 (N-67-22260) STUDY IN COMETARY ASTROPHYSICS. Quarterly Report, November 20, 1966-February 20, 1967. (Melpar, Inc., Falls Church, Va.). Mar. 10, 1967. Contract NASw-1417. 31p. (NASA-CR-83398). CFSTI.

Emission spectra produced by electron bombardment of low pressure gases are being studied. The selective production of C_3 or C_2 from simple molecules may have important cometary implications and the production of C_3 from CH_4 is considered to occur by a very rapid reaction. The intensity of the C_3 emission was found to increase in experiments using low energy electrons. Studies of the rate of the collisional interchange of the singlet and triplet states of C_2 are continuing. Measurements in shock heated cyanogen show that the singlet state is produced more rapidly than the triplet state. Photochemical decomposition in the far ultraviolet of methylacetylene at low pressure, leading to the formation of molecular hydrogen, atomic hydrogen, and acetylene, was initiated. Molecular hydrogen formation assumes increasing importance relative to other processes at shorter wavelength. Direct production of C_3 from methylacetylene appears to be considerably less important than it is in the decomposition of acetylene or diacetylene. (auth)

942 (ORNL-AMPIC-7) BIBLIOGRAPHY OF ATOMIC AND MOLECULAR PROCESSES FOR JANUARY-JUNE 1966. (Oak Ridge National Lab., Tenn.). Oct. 1967. Contract W-7405-eng-26. 195p. Dep. CFSTI.

This annotated bibliography contains references of interest to atomic and molecular processes research. Bibliographical sources consisted of seventy-six scientific journals and five abstract journals. The references are classified into fourteen major categories with appropriate subcategories. Each entry in the respective category is entered alphabetically and includes the reactants or the atomic and molecular system of interest. (auth)

943 (ORNL-TM-1988) THE MEASUREMENT OF HIGH-ENERGY CHARGE TRANSFER CROSS SECTIONS FOR INCIDENT PROTONS AND ATOMIC HYDROGEN IN VARIOUS GASES AND THE K-, L-, AND M-AUGER, L-COSTER-KRONIG, AND THE CONVERSION-ELECTRON SPECTRA OF PLATINUM IN THE DECAY OF ^{195}Au. Toburen, L. H.; Nakai, M. Y.; Langley, R. A. (Oak Ridge National Lab., Tenn.). Nov. 1967. Contract W-7405-eng-26. 231p. Dep. CFSTI.

Thesis. Submitted by L. H. Toburen to Vanderbilt Univ., Nashville, Tenn.

In Part I the single-electron capture and loss cross sections are reported for incident protons and atomic hydrogen on the target gases H_2, He, Ar, Kr, N_2, O_2, CO, CO_2, H_2O, CH_4, C_2H_4, C_2H_6, and C_4H_{10}. The incident particle energies were from 100 to 2500 keV. Results of measurement of double-electron capture cross sections for the target gases H_2, He, Ar, Kr, N_2, and H_2O for incident protons with energies in the range 75 to 250 keV are also presented. In Part II ^{195}Pt K-, L-, and M-Auger and L-Coster-Kronig spectra measurements using the Vanderbilt iron-free, double-focusing, β-ray spectrometer are reported. The conversion-electron spectrum in the electron capture decay of ^{195}Au was also recorded using the same spectrometer. In each part, theory, apparatus, and measurement techniques are described, and results are compared with previous experiments and theoretical calculations. (A.G.W.)

944 (UCRL-17756) SINGLE AND DOUBLE ELECTRON CAPTURE BY 7.7- TO 166-keV $^3He^{++}$ IONS IN N_2. Stearns, John Warren (California Univ., Berkeley. Lawrence Radiation Lab.). Sept. 11, 1967. Contract W-7405-eng-48. 34p. Dep. CFSTI.

Thesis.

The cross sections, σ_{21} and σ_{20}, for single and double electron capture of $^3He^{++}$ ions with energies between 7.7 and 166 keV have been measured in thin targets of N_2. The $^3He^{++}$ ions were extracted from an rf source and accelerated electrostatically. After momentum analysis by a 90° magnet, they passed through the target chamber and were reanalyzed electrostatically. The charged components, $^3He^{++}$ and $^3He^+$, were detected by a pair of Faraday cups, and the neutral component $^3He^0$ by a CsI(Tl) crystal mounted on a photomultiplier tube. Currents from these detectors were simultaneously integrated, and measurements were made for at least eight pressures at each energy. Pressures were measured with a capacitance manometer. Both σ_{21} and σ_{20} have maxima at about 50 keV, which are $\sigma_{21} = (13.0 \pm 1.3) \times 10^{-16}$ and $\sigma_{20} = (3.3 \pm 0.7) \times 10^{-16}$ cm^2/molecule. The results agree with those of Allison for $^4He^{++}$ in the region where the velocities overlap ($^3He^{++}$ energies between 112.5 and 166 keV). The results are compared with available theoretical models. (auth)

945 (CLM-Trans-10) TRANSFER OF RADIATION IN A SPECTRAL LINE. Ivanov, V. V. Translated for Culham Lab., Abingdon, Eng., from Uch. Zap. Leningrad. Gos. Univ., Ser. Mat. Nauk, No. 39, 44-65[1965]. 23p. Dep. CFSTI. JCL $2.60 fs, $0.89 mf. UK 3s.

An attempt is made to determine those properties of the solutions of the transfer equation which might facilitate its numerical solution and improve the accuracy of the approximate methods. Simplifications in the structure of the radiation field are investigated which come about when true absorption plays only a small part. (M.H.R.)

946 LEGENDRE POLYNOMIAL EXPANSION FOR THE KLEIN-NISHINA FORMULA. Renken, James H. (Sandia Lab., Albuquerque, N. Mex.). J. Appl. Phys., 38: 4925-7(Nov. 1967).

The differential cross section for the scattering of unpolarized photons by stationary, free electrons (Compton scattering) was first derived by Klein and Nishina. When the Klein-Nishina formula becomes more anisotropic at higher photon energies, knowledge of the energy dependence of the Legendre polynomial expansion coefficients provides a qualitative picture of how the angular dependence of the scattering yield is changing with incident photon energy. The derivation of the required energy-dependent expansion coefficients is considered. The behavior of the formulas is illustrated by numerical results. (M.H.R.)

947 SIMPLE THEORY FOR K IONIZATION BY RELATIVISTIC ELECTRONS. Kolbenstvedt, H. (NBS, Washington, D. C. Norges Laererhoegskole, Trondheim, Norway). J. Appl. Phys., 38: 4785-7(Nov. 1967).

The total cross section for ionization of K electrons by electrons has been derived using the method of virtual photons combined with the photoelectric cross section for distant collisions and the Moeller cross section for close collisions. Good agreement with experiments is obtained for the elements silver (Z = 47) and tin (Z = 50) when the electron energy is much higher than the ionization energy. (auth)

948 VELOCITY DISTRIBUTION OF CATHODE-SPUTTERED POTASSIUM. Hulpke, E.; Schlier, Ch. (Univ., Freiburg i. B.). Z. Phys., 207: 294-307(1967). (In German).

The differential sputtering ratio (energy spectrum) of polycrystalline potassium sputtered by Ar and Xe ions of 28-keV energy has been measured using surface ionization detection. The spectrum shows a maximum at 0.5 eV and drops to half the maximum value at 2.0 eV. The total sputtering ratio for incident Xe ions is found to be 2.7 ± 1.3 atoms/ion. To check what influence the detector might have on the measured spectrum, different materials and temperatures were used. Below 3 eV the detection probability is energy independent, if the detector is properly heated. Above that energy the measured spectra becomes uncertain, probably because of the onset of reflexion. Therefore the "focussing energy" of sputtering theory cannot be deduced. (auth)

949 ANOMALOUS EQUILIBRIUM PROPERTIES FOR A SYSTEM OF INTERACTING MATTER AND RADIATION. Premanand, Jayaseetha (Tata Inst. of Fundamental Research, Bombay); Falkoff, D. L. Phys. Rev., 163: 178-81(Nov. 5, 1967).

A simple model was made for the interaction of matter and radiation and its equilibrium properties were obtained from the time-independent solutions of the master equation. Apparent anomalies result for matter and photons in (i) the final temperature, (ii) distribution functions for populations, (iii) fluctuations, and (iv) detailed balancing. These anomalies are physically explained and are shown to be due to the severe constraints in the model imposed by the relevant conservation laws. (auth)

950 ELASTIC SCATTERING OF PHOTONS BY A HYDROGEN ATOM. Gavrila, Mihai (Bucharest Univ.). Phys. Rev., 163: 147-55(Nov. 5, 1967).

An exact analytic expression is derived for the Kramers-

Heisenberg matrix element describing the elastic scattering of photons by a hydrogen atom in the dipole approximation. The method followed consists in writing the matrix element in terms of the Coulomb-field Green's function in momentum space and using for this an integral representation originally derived by Schwinger. Various integrations then yield the matrix element in terms of a hypergeometric function of the Gauss type ${}_2F_1$ with parameters and variable depending on the photon energy. Different limiting cases are considered. Finally, a very accurate numerical computation of the result is reported. The procedure used in the computation was to sum the series expansions of the hypergeometric functions occurring in the different equivalent conveniently chosen forms of the matrix element. The results presented cover all values of the photon energy. (auth)

951 PRECISE THEORY OF THE ZEEMAN SPECTRUM FOR ATOMIC HYDROGEN AND DEUTERIUM AND THE LAMB SHIFT. Brodsky, Stanley J.; Parsons, Ronald G. (Stanford Linear Accelerator Center, Calif.). Contract AT(04-3)-515. Phys. Rev., 163: 134-46(Nov. 5, 1967). (SLAC-PUB-293).

A complete and straightforward analysis is given of the n = 2 Zeeman structure which is intrinsically accurate to 1 ppm for determining the Lamb shift from present experiments. This analysis takes into account the current experimental and theoretical knowledge of the atomic Hamiltonian. It is shown that the magnetic part of this Hamiltonian can be taken as that of a free electron and a free nucleus. Radiative corrections to this assumption are shown to be negligible. The total Hamiltonian can then be diagonalized in the $|F, j, l, m_F>$ representation. Matrix representations of the Hamiltonian are given for all n = 2 states of hydrogen and deuterium. Theoretical predictions are given for the l = 1 hyperfine intervals in hydrogen and deuterium which are accurate to 10 ppm. Values of the Lamb shift calculated from the recent Zeeman level crossings of Robiscoe and Cosens are tabulated. (auth)

952 POSITRONIUM FORMATION IN POSITRON–HYDROGEN SCATTERING. Fels, Margaret Fulton; Mittleman, Marvin H. (Univ. of California, Livermore). Contract W-7405-eng-48. Phys. Rev., 163: 129-34(Nov. 5, 1967). (UCRL-14758 (Rev.1)).

A pair of coupled equations describing positron–hydrogen scattering in the energy range where only positronium in its ground state may be formed is solved numerically. The equations, unlike others previously derived, are local to lowest order. The effects of the polarizability of both hydrogen and positronium are included in various ways. The s-wave phase shift at threshold is close to that obtained previously by solution of the nonlocal equations when no polarization is included, and is dramatically improved when polarization of both hydrogen and positronium is included. The positronium formation cross section is about 40 times smaller than the Born approximation. These are the only comparisons with previous work available. (auth)

953 MEASURED LIFETIME OF THE $(3p^54s)^3P_1$ STATE OF ARGON. Morack, J. L.; Fairchild, C. E. (Oregon State Univ., Corvallis). Phys. Rev., 163: 125-9(Nov. 5, 1967).

A direct measurement of the natural lifetime for the $(3p^54s)^3P_1$ state of argon has been made using a modified delayed-coincidence method. Argon atoms are repetitively excited by pulses of electrons. For each pulse, the decaying light signal is sampled for a time Δt at some delay time t_1 after the excitation is terminated. The exponential decay is then reconstructed as the delay time is changed. Collision effects are not important in the pressure region $(5.0 \times 10^{-6} - 2.0 \times 10^{-4}$ Torr) of the experiment and the effects due to cascading are eliminated by keeping the energy of the bombarding electrons low enough so that excitation of the $3p^54p$ levels is negligible. The measured lifetime is dependent upon the argon pressure, and this effect is attributed to resonance trapping; a value of 21 ± 2 nsec is obtained for the natural lifetime by using the existing theories of resonance trapping to extrapolate the data to zero pressure. (auth)

954 VALIDITY OF THE SEMICLASSICAL METHOD FOR THE COUPLED-CHANNEL ATOMIC SCATTERING PROBLEM. Greenman, J. V. (Stanford Research Inst., Menlo Park, Calif.). Phys. Rev., 163: 119-24(Nov. 5, 1967).

The S-matrix elements for the two-channel atomic scattering system are not smoothly varying functions; hence some justification must be given for the application of the stationary-phase approximation to the evaluation of scattering amplitudes for this system. For a specific example, it is shown that the contribution to the amplitudes from the region of rapid variation is negligible compared to the stationary-phase value, since the region of rapid variation is small and the phases vary sufficiently slowly. The semiclassical interpretation of the oscillations in the elastic and inelastic cross sections as the "interference" between two classical trajectories is therefore a valid one. (auth)

955 CROSS SECTIONS FOR EXCITED-STATE MIXING IN CESIUM–NOBLE GAS COLLISIONS FROM D_2 OPTICAL PUMPING. Fricke, J. (Technische Hochschule, Munich); Haas, J.; Luescher, E.; Franz, F. A. Phys. Rev., 163: 45-53 (Nov. 5, 1967).

Cross sections for random collisional reorientation of J within the sublevels of the $6^2P_{\frac{1}{2}}$ excited state of cesium have been measured using the D_2 optical-pumping technique. The measured cross sections σ_M^2 are: Cs–He $(3.2 \pm 0.6) \times 10^{-15}$ cm^2, Cs–Ne $(2.9 \pm 0.6) \times 10^{-15}$ cm^2, Cs–Ar $(6.0 \pm 1.2) \times 10^{-15}$ cm^2, Cs–Kr $(9.2 \pm 1.9) \times 10^{-15}$ cm^2, Cs–Xe $(11.3 \pm 2.3) \times 10^{-15}$ cm^2. Simplified equations for D_1 and D_2 pumping with zero, partial, and complete excited-state mixing are derived for a hypothetical alkali atom with zero nuclear spin. The calculations are extended to cesium atoms with nuclear spin $\frac{7}{2}$ pumped by σ^+D_2 radiation. The equilibrium value $\langle S_z\rangle_0$ and the time dependence $\langle S_z(t)\rangle$ of the electronic spin polarization are computed for various degrees of excited-state mixing. $\langle S_z(t)\rangle$ is found to be nearly single-exponential in the zero- and the complete-mixing cases, but shows a distinct double-exponential behavior in the intermediate region. $\langle S_z\rangle_0$ is shown to be dependent on the degree of mixing, and to change sign as the degree of mixing increases. Measurements were performed with a new transmission technique by passing a separate σ^+-polarized D_2 pumping beam and an alternately σ^+- and σ^--polarized D_1 testing beam through the cesium absorption cell. The cross sections for collisionally induced mixing were evaluated by measuring the buffer pressure at which $\langle S_z\rangle_0$ passed through zero. (auth)

956 g_I/g_J RATIOS OF ^{85}Rb AND ^{87}Rb. Balling, L. C. (National Bureau of Standards, Boulder, Colo.). Phys. Rev., 163: 114-18(Nov. 5, 1967).

An optical-pumping experiment has been performed to measure g_I/g_J (^{85}Rb) and g_I/g_J (^{87}Rb). The measurements were made in a magnetic field of 40 G. The field was produced by a precision-wound solenoid surrounded by three coaxial magnetic shields. The magnetic field varied by three parts in 10^6 over the volume of the optical pumping cells. The optical-pumping cells were filled with various pressures of helium and neon buffer gases. The measured ratios did not depend upon the nature or pressure of the buffer gas. The results of the measurements were g_I/g_J (^{85}Rb) = $-1.46648(8) \times 10^{-4}$; g_I/g_J (^{87}Rb) = $-4.96997(9) \times 10^{-4}$. (auth)

957 ENERGY TRANSFER IN THE COLLISION OF ELECTRON BEAMS. Kolbenstvedt, H. (National Bureau of Standards, Washington, D. C. Norges Laererhoegskole, Trondheim, Norway). Phys. Rev., 163: 112-14(Nov. 5, 1967).

The cross section for electron–electron scattering, differential in energy transfer, is derived for the case that both electrons are in motion in the laboratory system. The result is valid for all electron energies much higher than the Rydberg energy. For the case in which both electrons are nonrelativistic and one of the electrons has an isotropic velocity distribution, the cross section is averaged over the directions of motion of that electron. (auth)

958 SURVIVAL PROBABILITY IN DISSOCIATIVE ATTACHMENT. Chen, Joseph C. Y.; Peacher, Jerry L. (Univ. of California, San Diego, La Jolla). Contract DA-31-124-ARO-D-257. Phys. Rev., 163: 103-11(Nov. 5, 1967).

The survival probability in dissociative attachment is investigated with special attention to the (e,H_2) system. It is shown that the simple expression for the dissociative-attachment cross section, as given by the product of a capture cross section and a survival probability, is equivalent to the s-wave approximation for the $g \rightarrow g$ dissociative attachment. This expression, however, does not constitute an approximation for the $g \rightarrow u$ dissociative attachment, since the parity of the initial rotational states of H_2 is always opposite to that of the relative angular momentum states of H and H^- and the capture cross section appearing in the simple expression is identically zero. According to the Kronig selection rules and the symmetry requirements, only odd partial waves of the incident electron may contribute to the $g \rightarrow u$ dissociative attachment in the (e, H_2) system. Consequently, the lowest contributing partial wave is not the s wave but the p wave of the incident electron. This, then, destroys the simple proportional dependence of the cross section on the survival probability. However, one may still express the cross section as a sum of products of a capture cross section and a survival probability for the various contributing angular momentum states of the constituent nuclei. The dependence of the survival probability on the angular momentum states of the constituent nuclei is also investigated for the (e, H_2) system. It is observed that for the $g \rightarrow u$ dissociative attachment the survival probability depends

strongly on the angular momentum states. This arises because the g → u dissociative attachment occurs at such a low energy that variations in the centrifugal barrier become comparable with the breakup energy of the constituent atoms. This then suggests a strong temperature dependence for the g → u dissociative attachment in the (e, H_2) system. For the g → g dissociative attachment, such dependence is much weaker since here the process becomes significant at a somewhat higher energy and the variation in centrifugal energy is overshadowed by the large break-up energy of the constituent atoms. The validity of the commonly adopted approximation for survival probability (involving the auto-ionization width and relative velocity of the nuclei) is also examined. (auth)

959 ELECTRON-IMPACT EXCITATION CROSS SECTION FOR THE TWO LOWEST TRIPLET STATES OF MOLECULAR HYDROGEN. Cartwright, David C.; Kuppermann, Aron (California Inst. of Tech., Pasadena). Contract AT(04-3)-532. Phys. Rev., 163: 86-102(Nov. 5, 1967). (CALT-532-11).

Calculations for the electron-impact excitation cross sections of molecular hydrogen from its ground ($X^1\Sigma_g^+$) to its first ($b^3\Sigma_u^+$) and second ($a^3\Sigma_g^+$) triplet states were performed using the Ochkur (O) and Ochkul-Rudge (OR) approximations. All nuclear motions were taken into account. It was found that the first triplet cross section is sensitive to the choice of the ground-state wave function whereas the second one is not. The former is also sensitive to the excited-state wave function used. The results using the O approximation are significantly larger than those of the OR approximation, and the maximum cross section occurs at a somewhat lower energy. Use of the separated-atom approximation produced results significantly lower than those arising from inclusion of all the multicenter terms in the scattering amplitude. The sum of the first and second OR triplet cross sections agrees well with a recent approximate experimental determination of the cross section for the electron-impact dissociation of H_2 into 2H. More accurate experiments are now needed to further test the OR approximation. (auth)

960 CHARACTERISTIC X-RAY PRODUCTION IN SINGLE CRYSTALS (Al,Cu,W) BY PROTON BOMBARDMENT. II. PROTONS OF 250 TO 1560 keV. Khan, J. M. (Univ. of California, Livermore); Potter, D. L.; Worley, R. D.; Smith, Harold P. Jr. Contract W-7405-eng-48. Phys. Rev., 163: 81-5(Nov. 5, 1967). (UCRL-14695(Pt.2)).

The study of the effect of proton channeling on the production of characteristic x rays in thick, metallic single crystals has been extended by the use of protons with energy between 250 and 1560 keV. The x-ray yields of Al K, Cu K, Cu L, W K, W L, and W M were measured as a function of the relative orientation of the crystal with respect to the direction of the incident beam. As in the previous study (Part I) minimum values of the x-ray yield were observed when the beam direction lies in crystal planes or along crystal directions having low indices. The relative x-ray yield is presented as a function of the orientation of the crystal planes with respect to the direction of the incident beam. The data indicate that the widths of the resulting curves (yield versus orientation in a plane) depend on the proton energy E_P as $1/(E_P)^{1/2}$. However, for a given element, the widths do not depend on the particular shell ionized. (auth)

961 IONIZATION FROM IRON ATOMS INCIDENT ON VARIOUS GAS TARGETS. Friichtenicht, J. F.; Slattery, J. C.; Hansen, D. O. (TRW Systems, Redondo Beach, Calif.). Phys. Rev., 163: 75-80(Nov. 5, 1967).

The ionization ratio β, which is defined here as the ratio of the number of ion-electron pairs N_I formed in a thick gas target to the number of atoms N_A injected into the gas at a given velocity, has been determined for Fe atoms impinging on target gases of He, Ne, Ar, Kr, N_2, O_2, CO_2, and air. The Fe atoms are generated in the gas by the vaporization of solid, submicron-diameter iron particles that are injected into the gas at high initial velocities ($15 < v < 45$ km/sec). The solid particles are nearly completely vaporized while suffering small deceleration, and N_A is derived from the measured initial mass of the particle. Atoms evaporated from the particle travel through the gas at approximately the injection velocity of the particle. N_I is determined by means of a parallel-plate ionization chamber. For a single collision, β is closely given by the ratio of the ionization cross section σ_I to the momentum-loss cross section σ_D. In the energy range covered by the experiment, σ_D is a slowly varying function of energy and may be replaced by a constant multiple of σ_G, the geometrical cross section. If the number of collisions where ionization is energetically possible is small, σ_I can be estimated from β. For the particular case of Fe → N_2 we obtain $\sigma_I \approx 0.6\ \sigma_G$ at an Fe-atom velocity of 40 km/sec. This is in qualitative agreement with the value reported by other experimenters using more conventional atomic-beam techniques. (auth)

962 RELATIVISTIC EFFECTS IN LOW-ENERGY ELECTRON SCATTERING BY ATOMS. Dawson, John F. (Lowell Technological Inst., Mass.). Phys. Rev., 163: 71-4(Nov. 5, 1967).

Low-energy electron-scattering phase shifts and bound-state energies of neutral atomic potentials are computed using the Fredholm method. The relativistic and nonrelativistic results are compared. It is concluded that relativistic corrections to the phase shifts are unimportant for the potentials considered here. (auth)

963 FINITE ELECTRONIC PARTITION FUNCTION FROM SCREENED COULOMB INTERACTIONS. Rouse, Carl A. (Naval Research Lab., Washington, D. C. Univ. of California, Berkeley). Phys. Rev., 163: 62-71(Nov. 5, 1967).

A definition of a finite partition function for bound electronic states is presented for a hydrogenic ion, with the associated problems of the fall in intensity of spectral lines and the lowering of the effective ionization potential. The partition function is partly based on numerical solutions of the Schrödinger equation (SE) with the complete screened Coulomb potential (CSCP), where the 1s, 2s, 2p, 3s, 3p, and 3d states are considered. Correlations with observations are discussed: there is excellent agreement with the fall in intensity of hydrogen lines in the solar atmosphere and good agreement with lines from laboratory hydrogen at 21°K. The effective ionization potential of hydrogen is calculated using the maximum detected level of hydrogen observed in the solar chromosphere. A simple analytical fit to the Φ function and a useful approximate analytical expression for the screened Coulomb partition function are given. (auth)

964 ATOMIC SELF-CONSISTENT-FIELD CALCULATIONS USING STATISTICAL APPROXIMATIONS FOR EXCHANGE AND CORRELATION. Cowan, Robert D. (Los Alamos Scientific Lab., N. Mex.). Contract W-7405-eng-36. Phys. Rev., 163: 54-61(Nov. 5, 1967). (LA-DC-8695).

The $\rho^{1/3}$ approximation introduced by Slater for the exchange terms in the Hartree-Fock (HF) equations, with or without Latter's cutoff in the tail of the potential function, leads to serious errors when applied to excited configurations of atoms. A more accurate approximation (HX) is suggested in which Hartree's method is used for the self-interaction correction, and a modification of the Slater $\rho^{1/3}$ term is used to approximate the remainder of the HF exchange terms. The HX scheme is fairly simple; iterative convergence to self-consistent-field solutions is quite stable; and the resulting one-electron radial wave functions produce acceptably accurate values of one-electron and total binding energies, interaction parameters F^k, G^k, and ζ_{nl}, and expectation values of r^n. Perturbation-theory relativistic and correlation corrections are computed; the latter are based on the free-electron approximation, with empirical modifications to allow for differences between free and bound electrons. Results agree well with experimental ionization and excitation energies for a wide variety of configurations. (auth)

965 DISSOCIATION OF N_2^+ AND O_2^+ BY ELECTRON IMPACT. Van Zyl, Bert; Dunn, Gordon H. (Joint Inst. for Lab. Astrophysics, Boulder, Colo.). Phys. Rev., 163: 43-5 (Nov. 5, 1967).

Cross sections for dissociation of N_2^+ and O_2^+ by electron impact were measured for interaction energies E between 10 and 500 eV and between 15 and 500 eV, respectively. The cross-section-versus-interaction-energy curves exhibit maxima in the vicinity of 75 eV and decrease monotonically at higher energies with an (A/E) log BE dependence. Maximum cross-section values are $4.3\pi a_0^2$ for N_2^+ and $4.1\pi a_0^2$ for O_2^+. The curves are remarkably similar at the higher interaction energies. The ion targets are typical of those formed by bombardment of gas by electrons of 150 eV and more, and some may be in excited electronic states. (auth)

966 SEMIEMPIRICAL CALCULATION OF THE DIFFERENTIAL ENERGY EXPENDED PER ION PAIR FOR FISSION FRAGMENTS IN H_2. Mulas, Pablo (Instituto Politecnico Nacional, Mexico City). Contract AT(30-1)-2807. Phys. Rev., 163: 38-42(Nov. 5, 1967). (NYO-2807-30).

High and low limits for the variation of w_H, the differential energy expended per ion pair, are calculated for the average-energy ^{252}Cf fission fragment in H_2. The electronic and nuclear stopping cross sections are obtained from the "unified" range theory for heavy ions constructed by Lindhard and co-workers and from recent experimental energy-distance data. Published experimental data of primary ionization cross sections for protons in hydrogen over the appropriate recoil energies yield the high limit. The low limit is obtained when protons are considered to expend energy in the creation of an ion pair at the same rate for their whole trajectory as they do at very high energies. The

variation of w_{ff} with fission-fragment energy can be calculated if total ionization cross sections of the stopping-medium knocked atoms and energy–distance curves of the incident particles are known. (auth)

967 EXCITATION OF ATOMIC OXYGEN AND CARBON BY COLLISIONS WITH HYDROGEN ATOMS. Callaway, Joseph; Dugan, Anthony F. (Univ. of California, Riverside). Phys. Rev., 163: 26-33(Nov. 5, 1967).

Cross sections are calculated for the excitation of fine-structure levels in neutral atomic oxygen and in both neutral and singly ionized carbon by collisions with neutral hydrogen atoms. The appropriate reaction rates are averaged over a Maxwell distribution of relative velocities, and the results are applied to a discussion of atomic cooling processes in the interstellar medium. (auth)

968 ELECTRON CAPTURE BY ALPHA PARTICLES INCIDENT ON ATOMIC HYDROGEN. Basu, D.; Bhattacharya, D. M.; Chatterjee, G. (Indian Association for the Cultivation of Science, Jadavpur). Phys. Rev., 163: 8-12(Nov. 5, 1967).

A calculation of capture probability and the total capture cross section of the electron in the system $He^{++} + H \rightarrow He^{+} + H^{+}$ has been made taking into account the couplings of the initial state with the 1s, 2s, $2p_0$, and $2p_{\pm1}$ states of He^{+} ion. In the low-energy region, the numerical results for the capture probability agree partly with the experiments of Keever and Everhart. The nature of decrease of calculated total capture cross section with decreasing energy agrees well with the experimental findings of Fite, Smith, and Stebbings. (auth)

969 ANGULAR DEPENDENCE OF THE COLLISION-INDUCED EXCITATION OF H_2^+. Gibson, D. K.; Los, J.; Schopman, J. (FOM-Instituut voor Atoom- en Molecuulfysica, Amsterdam). Phys. Lett., 25A: 634-5(Oct. 23, 1967).

Some measurements of the angular dependence of the collision-induced excitation cross section of H_2^+ are presented. These measurements suggest that simultaneous excitation of the target atom is not negligible. (auth)

970 RABI-TYPE STATE-SELECTOR WITH FOCUSING PROPERTIES FOR MOLECULAR BEAMS. Reuss, J.; Nelissen, L. (Katholieke Univ., Nijmegen, Netherlands). Phys. Lett., 25A: 626-7(Oct. 23, 1967).

A focusing device suitable for molecular beams is simply constructed by arranging four identical pairs of Rabi pole pieces in series to form a cylindrical lens with a plane of symmetry. (A.G.W.)

971 ELEMENTARY PROCESS IN BREMSSTRAHLUNG PRODUCTION. Nakel, W. (Univ., Tuebingen, Ger.). Phys. Lett., 25A: 569-70(Oct. 23, 1967). (In German).

By using a coincidence method the angular distribution of bremsstrahlung is measured for a definite energy loss and a definite angle of the outgoing electron. A comparison with theoretical predictions is given. (auth)

972 SPIN–ROTATION CONSTANTS IN H_2O, HDO, AND D_2O. Bluyssen, H.; Dymanus, A.; Reuss, J.; Verhoeven, J. (Katholieke Univ., Nijmegen, Netherlands). Phys. Lett., 25A: 584-5(Oct. 23, 1967).

Diagonal elements $M_{aa}^{(K)}$ of the tensor representing coupling between the rotational angular momentum of the molecule and the spin of Kth nucleus have been determined from spin–rotation constants of H_2O, HDO, and D_2O. (auth)

973 SPACE CHARGE EFFECTS IN THE TOWNSEND–HUXLEY SWARM TECHNIQUE. Liley, B. S. (Australian National Univ., Canberra). Aust. J. Phys., 20: 527-45(Oct. 1967).

An analytical treatment of space charge effects in the Townsend–Huxley swarm technique is given. The general case of a mixed swarm of equally charged ions and electrons drifting through a gas in which attachment is possible is considered. The case of a pure electron or pure ion swarm is treated as a particular case of the general one. The main result is an expression for R(r,z), this being the ratio of the current collected by a disk of radius r, in the plane z = z, to the total swarm current. This ratio is determined as an explicit function of D/μ, the total current, the electron (or ion) current, and the attachment coefficient. It is shown that space charge effects can be of importance for large currents, low E/p, and low gas temperatures. Moreover, in practice such effects are only likely to be of interest in thermal swarms. (auth)

974 MEASUREMENT OF THE MAGNETIC DRIFT VELOCITY AND MAGNETIC DEFLECTION COEFFICENT FOR SLOW ELECTRONS IN HYDROGEN AND DEUTERIUM AT 293°K. Creaser, R. P. (Australian National Univ., Canberra). Aust. J. Phys., 20: 547-55(Oct. 1967).

The magnetic drift velocity W_M relating to the drift of an electron swarm in crossed electric and magnetic fields was measured in hydrogen and deuterium at 293°K. The measurements were made using Huxley's method of measuring W_x/W_z, the ratio of the transverse to the longitudinal drift velocity. Data are given for W_M and for the magnetic deflection coefficient Ψ for $6.1 \times 10^{-19} < E/N < 2.7 \times 10^{-16}$ V cm² for hydrogen and $6.1 \times 10^{-19} < E/N < 2.4 \times 10^{-16}$ V cm² for deuterium. (auth)

975 IDENTITY OF THE IONS CREATED BY ELECTRON IMPACT IN FLAMES. Feugier, A.; Van Tiggelen, A. (Univ. of Louvain, Belg.). Combust. Flame, 11: 234-8(June 1967).

Electrons which were present in flame gases burning at atmospheric pressure were accelerated to create secondary ions by bombardment of the neutral species in the burnt gases at low pressure. The masses of the positively charged species obtained were identified by mass spectrometry. Some processes of proton and charge transfer are discussed. Formaldehyde was shown to be present in the burnt gases of the 3 types of hydrocarbon flames investigated. This corresponded to a previous interpretation given to the nature of the negative ions in hydrocarbon flames. The presence of acetylene in the burnt gases, even in stoichiometric mixtures, seemed to be a general phenomenon in hydrocarbon–oxygen flames. This corresponded also to the observation of C_2H^- as an important negative ion in the same flames. Unburnt fuel molecules were still present in the flue gases. Proton transfer reactions are very rapid processes, and occur with many kinds of species. (BBB)

976 EFFECTS OF STRONG INTERACTIONS AND FINITE NUCLEAR CHARGE RADIUS IN PIONIC ATOMS. Fulcher, L. P. (Univ. of Virginia, Charlottesville); Eisenberg, J. M.; LeTourneux, J. Can. J. Phys., 45: 3313-18(Oct. 1967).

For studies involving the interaction of bound pions with the atomic nucleus, it is essential to investigate details of the pionic wave function at the nucleus. These are especially important for the 1S orbitals, where both the repulsive strong interaction and the effects of finite nuclear charge radius are important. Some calculations based on the use of a square-well potential to simulate the strong interactions are presented. The nuclear charge distribution is taken to be that of a uniformly charged sphere. The corresponding Schrödinger equation is solved exactly. The square-well radius is taken to be the same as the nuclear radius, and its strength is chosen so as to obtain agreement with the observed 2P–1S energy differences. For light nuclei, the probability of finding the meson in the nucleus is found to be approximately 25 to 50% of that calculated with conventional hydrogenic wave functions. (auth) (CANADA)

977 CESIUM-ION BOMBARDMENT OF ALUMINUM OXIDE IN A CONTROLLED OXYGEN ENVIRONMENT. Hasseltine, E. H.; Hurlbut, F. C.; Olson, N. Thomas; Smith, Harold P. Jr. (Univ. of California, Berkeley). J. Appl. Phys., 38: 4313-16(Oct. 1967).

Sputtering of aluminum oxide (sapphire) by 2.5- to 10-keV cesium ions has been investigated using neutron activation analysis. The sputtering yield (aluminum atoms/ion) was measured as a function of ion energy, target temperature, and R, the ratio of background oxygen molecular flux arriving at the target surface to the sputtered aluminum and oxygen flux leaving the surface. Positive-charge accumulation on the dielectric surface was neutralized by electron flooding of the ion-beam area while the ion current was measured by a periodic beam deflection technique. In all measurements the ion beam was normal to the target surface and the (001) crystallographic plane. The yield increased monotonically from 0.40 (aluminum atoms/ion) at 2.5 keV to 0.52 at 10 keV and was unaffected for R < 0.1. The yield decreased slightly as R was increased, and for R > 10 it approached the saturation value of monocrystalline aluminum. The yield exhibited a temperature dependence decreasing from 0.55 at 77°K to 0.48 at 475°K. The results were reproducible to within 5%. (auth)

978 RANGE–ENERGY RELATIONS FOR LOW-ENERGY IONS. Schioett, Hans E. (Univ. of Aarhus, Denmark). Kgl. Dan. Vidensk. Selsk., Mat.-Fys. Medd., 35: No. 9, 20p(1966).

Supplementary data on proton and deuteron ranges in targets of high density are given, in a continuation of the report of Lindhard, et. al. (Kgl. Dan. Vidensk. Selsk., Mat.-fys Medd. 33: No. 14 (1963)). An appendix provides integral equations describing the distribution in projected range. Projected ranges were calculated for low-energy light particles in heavy substances (e.g., 20-keV deuterons in gold), together with straggling in projected range, assuming randomness of stopping material. The projected range was found to be considerably less than the range along the path,

and the distribution in projected range to be very broad. The range ratio $\overline{R_p}/\overline{R}$, as well as the relative straggling $\overline{\Delta R_p^2}/\overline{R_p^2}$, is independent of stopping substance when a reduced energy measure, ϵ, is used, and is not strongly dependent on the at. no. of the projectile. As an extension of the earlier report, range-energy tables covering a large number of combinations of incoming particle and target materials are presented. (BBB)

979 STOPPING CROSS SECTION IN CARBON OF 0.1 TO 1.0-MeV ATOMS WITH $6 \leq Z_1 \leq 20$. Fastrup, B.; Hyelplund, P.; Sautter, C. A. (Univ. of Aarhus, Denmark). Kgl. Dan. Vidensk. Selsk. Mat.-Fys. Medd., 35: No. 10, 28p(1966).

The Univ. of Aarhus 600-kV heavy-ion accelerator, provided with a universal ion source, was used to furnish projectiles for determination of the stopping cross section, (1/N)/dE/dx), in thin carbon foils for ions with at. no. Z_1 from 6 to 20 with energies from 100 keV to 1 MeV. The data obtained were corrected numerically for nuclear stopping to obtain the electronic stopping cross section. This cross section had an oscillatory dependence on Z_1 for constant ion velocities. The analysis suggested that the relative amplitude of the oscillations decreases as the ion velocities increase. Apart from the oscillations, the experimental data were in reasonable agreement with the theoretical predictions. The relative accuracy of the measured data was about 2 to 3%, and the absolute accuracy of the evaluated electronic stopping cross sections exceeded 8% even in the most extreme cases (low energy and high Z_1). (BBB)

980 PRELIMINARY RESULTS OF A THREE-DIMENSIONAL HARD-SPHERES THEORY OF SCATTERING OF GAS ATOMS FROM A SOLID SURFACE. Goodman, F. O. (Massachusetts Inst. of Tech., Cambridge). pp 35-48 of Proceedings of the Fifth International Symposium on Rarefied Gas Dynamics. Brundin, C. L. (ed.). London, Academic Press, 1967.

See CONF-660709.

A three-dimensional model of the interaction of monatomic gases with solid surfaces is described. The solid surface is represented by similar, noninteracting, hard spheres, the centers of which form initially a regular two-dimensional array; an incident gas atom is represented by a hard sphere incident on this array. Collisions between the gas atom and the surface atoms obey the ordinary laws of classical hard spheres. Three closely related problems are discussed, involving calculations of (i) the detailed velocity distribution of the gas atoms reflected from the surface, (ii) the energy and momentum accommodation coefficients, and (iii) the forces exerted on a target by a directed gas beam. Some preliminary conclusions are drawn and illustrated by results for some special cases. (auth) (UK)

981 SCATTERING OF MOLECULAR BEAMS OF He, D_2, AND H_2 FROM THE (111) PLANE OF Ag. Saltsburg, Howard; Smith, Joe N. Jr.; Palmer, Robert L. (General Atomic Div., General Dynamics Corp., San Diego, Calif.). pp 223-38 of Proceedings of the Fifth International Symposium on Rarefied Gas Dynamics. Brundin, C. L. (ed.). London, Academic Press, 1967.

The spatial distributions of H_2, He, and D_2 scattered from the (111) plane of epitaxially grown Ag were measured both in, and transverse to, the plane of incidence. All three gases show sharper distributions out-of-plane than in-plane. Both H_2 and He show, in addition to a specular scattering maximum, another temperature dependent scattering peak, which is nonspecular at 80°K and becomes specularly directed at 1400°K. This nonspecular peak is assumed to be a result of energy-transfer processes. For D_2, the specular peak is very much smaller, the temperature-dependent scattering dominating the observed distribution. The elastic specular peak is due to <5% of the scattered atoms for He and H_2 and <0.5% for D_2. Rather than resulting solely from the difference in the magnitude of the interaction potential, evidence is presented indicating that rotational-state interactions of the diatomic molecule contribute to the differences in the scatterings of He and D_2. (auth) (UK)

982 MOLECULAR BEAM SCATTERING FROM SURFACES OF VARIOUS METALS. Hinchen, J. J.; Shepherd, E. F. (United Aircraft Corp., East Hartford, Conn.). pp 239-52 of Proceedings of the Fifth International Symposium on Rarefied Gas Dynamics. Brundin, C. L. (ed.). London, Academic Press, 1967.

See CONF-660709.

The influence of gas temperature on the quasi-specular scattering of helium, neon and argon beams from polycrystalline platinum was examined, and the location of the scattering maxima was found to be markedly affected by variations in this temperature. Changes in beam incidence angle and molecular weight of the beam gas produced variations in the dependence of the maxima positions on beam temperature. The experimental results are in fair agreement with theoretical treatments of scattering, which have as a basic assumption that accommodation between gas atoms and a surface alters only the normal component of the incident gas velocity, with a resultant change in reflection angle. In an evaluation of the influence of surface composition on scattering, it was observed that considerable grain growth had occurred as a result of heating the polycrystalline platinum target, and the large strain-free single crystals formed were oriented with (110) planes parallel to the surface. Quasi-specular scattering of argon from this surface was similar to results obtained with a single crystal platinum surface cut along the (111) plane. The effect of oxidizing the platinum surface, investigated with oxygen beams, was to cause a transition from quasi-specular to diffuse scattering that was dependent on gas and surface temperatures. Quasi-specular scattering of argon and nitrogen was observed from surfaces of nickel, tantalum and tungsten, but the scattering distributions were considerably broader than with platinum. (auth) (UK)

983 EXPERIMENTAL STUDY OF SCATTERING IN PARTICLE-SURFACES COLLISIONS WITH PARTICLE ENERGIES OF THE ORDER OF 1 eV. Alcalay, Jack A.; Knuth, Eldon L. (Univ. of California, Los Angeles). pp 253-68 of Proceedings of the Fifth International Symposium on Rarefied Gas Dynamics. Brundin, C. L. (ed.). London, Academic Press, 1967.

See CONF-660709.

Distributions for scattering of chopped argon beams with particle energies of the order of 1 eV from various silver, mica, and brass surfaces were found, unexpectedly, to contain three distinct lobes in the plane defined by the surface normal and the incident beam. Although this scattering pattern shifted slightly toward the diffuse pattern as surface roughness and contamination increased, the three lobes were observed even for contaminated polycrystalline surfaces, for which for thermal-energy beams the diffuse pattern would be expected. Other observed features of the scattering include (a) an increase of scattering (at least near the aforementioned plane) as the surface contamination increases, (b) for the quasispecular lobe, more scattering near this plane than for other azimuthal angles, (c) two maxima in some of the detector signals (time-dependent pulses), and (d) longer detector signals near the incident beam angle than at other angles. (auth) (UK)

984 SPEED DISTRIBUTION OF SCATTERED MOLECULES AFTER THE IMPACT OF A HIGH VELOCITY MOLECULAR BEAM ON A SOLID SURFACE. Devienne, F. M.; Roustan, J. C.; Clapier, R. (LMRT, Nice). pp 269-88 of Proceedings of the Fifth International Symposium on Rarefied Gas Dynamics. Brundin, C. L. (ed.). London, Academic Press, 1967.

See CONF-660709.

The experiments described concern the direct speed measurement of scattered molecules after the impact of a high velocity molecular beam of argon on a solid surface of aluminum. The energy of the beam was about 2,100 eV. (auth) (UK)

985 AN EXPANSION METHOD FOR CALCULATING ATOMIC PROPERTIES. X. $1s^2\,{}^1S - 1snp\,{}^1P$ TRANSITIONS OF THE HELIUM SEQUENCE. Dalgarno, A.; Parkinson, E. M. (Queen's Univ. of Belfast). Proc. Roy. Soc. (London), Ser. A, 301: 253-60(1967).

The electric dipole matrix elements connecting the $1s^2\,{}^1S$ and $1snp\,{}^1P$ states of the helium isoelectronic sequence are calculated exactly to first order in inverse powers of the nuclear charge Z, and the differences from the Hartree–Fock approximation are shown to correspond to virtual transitions of the 1s electrons. Comparison of the oscillator strengths predicted by a screening approximation with more accurate values reveals a regular variation in the error contained in the screening approximation, the correction of which allows the prediction of oscillator strengths and probabilities of $1s^2\,{}^1S - 1snp\,{}^1P$ transitions for all values of n and all values of Z within a probable error of 2% (table 5). Values of the photoionization cross sections at the spectral heads are also presented. (auth) (UK)

986 THE RECOILLESS FRACTION AND THE THERMAL SHIFT FOR ^{129}I 26.8-keV TRANSITION IN CsI. Kamal, R.; Mendiratta, R. G.; Raju, S. B.; Tiwari, L. M. (Indian Inst. of Tech., New Delhi). Phys. Lett., 25A: 503-4(Oct. 9, 1967).

The recoilless fractions and the thermal shifts for CsI are calculated at various temperatures using the phonon frequency distribution. The results are discussed and compared with the available experimental values. (auth)

987 QUANTUM EFFECTS IN MAGNETIC BREMSSTRAHLUNG. Baier, V. N.; Katkov, V. M. (Inst. of Nuclear Physics, Novosibirsk, USSR). Phys. Lett., 25A: 492-3(Oct. 9, 1967).

An operator method for consideration of quantum effects when

ultrarelativistic particles radiate in an extermal field is given. For this method knowledge of the Heisenberg equations of motion of the particle is sufficient; solutions of wave equations are not used. (A.G.W.)

988 ON THE PHYSICAL REALITY OF ELECTROMAGNETIC POTENTIALS. Golub, R.; Carrico, J. P.; Stein, T. S.; Weisskopf, M. C. (Brandeis Univ., Waltham, Mass.). Phys. Lett., 25A: 495-6(Oct. 9, 1967).

On the basis of a recent proposal of de Beauregard, a shift, proportional to electrostatic potential, in the resonant frequency of an atom in a magnetic field is expected. Data are presented on a beam of K atoms, which fail to show this shift. (auth)

989 ELASTIC DIFFERENTIAL CROSS SECTIONS IN He^+–He COLLISIONS AT 680 TO 3100 eV. Baudon, J.; Abingnoli, M.; Barat, M.; Pernot, A. (CNRS, Orsay, France. Faculte des Sciences, Orsay, France). Phys. Lett., 25A: 564-5(Oct. 9, 1967).

Differential elastic cross sections in He^+–He collisions measured in the impact energy range 680 to 3100 eV (in laboratory coordinates) are reported. The oscillation pattern appearing on the $\sigma(\theta)$ curves has been explained theoretically by potential and nuclear symmetries of the He^+–He system. These oscillations were first observed by D. C. Lorents and W. Aberth and related to the oscillations of the symmetric charge exchange probability measured in a large energy range (130 eV to 100 keV) by E. Everhart et al. The location of minima and maxima obtained is in very good agreement with the results given by these authors. (auth)

990 NEW DIAGRAM LINES IN THE L-EMISSION SPECTRUM OF DYSPROSIUM. Nigam, A. N.; Garg, K. B. (Univ. of Rajasthan, Jaipur, India). Phys. Lett., 25A: 565-6(Oct. 9, 1967).

The L-emission spectrum of Dy was investigated using curved mica crystal transmission-type spectrographs of radii of curvature 20 and 40 cm. Four new diagram lines at 1450.5, 1792.0, 1663.2, and 1438.0 X. U. corresponding respectively to the dipole transition $L_{II}O_I$ (γ_8), the quadrupole transitions $L_{II}M_{III}$ (β_{17}), and $L_{III}N_{II}$, and the forbidden transition L_IN_I are reported for the first time. (auth)

991 SPIN POLARIZATION DURING ELECTRON RESONANCE SCATTERING BY NEON. Reichert, E.; Deichsel, H. (Univ., Mainz). Phys. Lett., 25A: 560-1(Oct. 9, 1967). (In German).

Spin polarization of 90° electron resonance scattering by neon atoms is investigated in a double-scattering experiment. (auth)

992 DECAY OF MOLECULAR HYDROGEN IONS THROUGH COLLISION WITH THERMAL ELECTRONS. Dubrovskii, G. V.; Ob'edkov, V. D. (Leningrad State Univ.). Sov. Astron. AJ (Engl. Transl.), 11: 305-7(Sept.-Oct. 1967).

Translated from Astron. Zh., 44: 387-9(Mar.-Apr. 1967).

The cross sections of the direct and inverse processes are calculated for the decay reactions $H_2^+ + e \rightarrow H' + H''$, in which hydrogen atoms in excited states are formed. At low temperatures the recombination rate is proportional to $T^{-\frac{1}{2}}$ and does not exceed 3×10^{-8} cm^3/sec. This result agrees with available experimental data. (auth)

993 SENSITIZED FLUORESCENCE IN VAPORS OF ALKALI METALS. IX. ENERGY TRANSFER IN COLLISIONS BETWEEN SODIUM AND INERT GAS ATOMS. Pitre, John; Krause, L. (Univ. of Windsor, Ont.). Can. J. Phys., 45: 2671-81(Aug. 1967).

The total cross sections for inelastic collisions between sodium and inert gas atoms, leading to $3\,^2P_{\frac{1}{2}} \rightarrow 3\,^2P_{\frac{3}{2}}$ excitation transfer in sodium, have been determined in a series of sensitized fluorescence experiments with sodium–inert gas mixtures. The sodium vapor was maintained at a pressure of 5×10^{-7} mm Hg, at which there is no trapping of the resonance radiation, and the inert gas pressures ranged from 0 to 1 mm Hg. The cross sections Q_1 ($3\,^2P_{\frac{1}{2}} \rightarrow 3\,^2P_{\frac{3}{2}}$) and Q_2($3\,^2P_{\frac{3}{2}} \leftarrow 3\,^2P_{\frac{1}{2}}$) are as follows: Na–He, 86.0 and 44.8 Å^2; Na–Ne, 67.0 and 35.4 Å^2; Na–Ar, 110 and 55.9 Å^2; Na–Kr, 85.0 and 43.6 Å^2; Na–Xe, 89.8 and 45.6 Å^2. The ratios Q_1/Q_2 are in agreement with the value predicted from the principle of detailed balancing and the cross sections also agree, as to order of magnitude, with some theoretically predicted values. (auth)

994 EFFECT OF TEMPERATURE ON THE PENETRATION OF HEAVY keV IONS IN MONOCRYSTALLINE SOLIDS. II. VARIOUS IONS IN GOLD, ALUMINIUM, AND TUNGSTEN. Howe, L. M.; Channing, D. A. (Chalk River Nuclear Labs., Ont.). Can. J. Phys., 45: 2467-82(Aug. 1967). (AECL-2924).

The influence of atomic thermal motion on the penetration of various heavy keV ions incident along low index channels of single crystals of gold, aluminum, and tungsten has been investigated over the temperature range 15 to 295°K. In general, in gold and aluminum the effect of thermal vibrations on the slowing down of the bombarding ions was quite pronounced, whereas a less marked effect was observed in tungsten. The magnitude of the temperature effect was dependent upon the type of bombarding ion and it is suggested that this is due, to a large extent, to the difference in the relative importance of electronic to nuclear stopping along the channel in the various systems. Thermal effects on the stability of the channeled trajectories are also believed to be important. The penetration of the channeled ions was observed to decrease exponentially with increasing temperature. In addition, the magnitude of the temperature effect was found to be relatively insensitive to the bombardment direction for incidence along the more open channels. (auth) (Canada)

995 EFFECT OF TEMPERATURE ON THE PENETRATION OF HEAVY keV IONS IN MONOCRYSTALLINE SOLIDS. I. ^{133}Xe IONS IN GOLD. Channing, D. A. (Chalk River Nuclear Labs., Ont.). Can. J. Phys., 45: 2455-66(Aug. 1967). (AECL-2912).

The effect of target temperature on the penetration distribution of 40-keV $^{133}Xe^+$ ions injected into oriented single-crystal gold has been measured from 20 to 295°K. The penetration was determined by the anodizing–stripping procedure of Whitton and Davies (1964), and the low-temperature irradiations were performed using a special liquid helium cryostat incorporated into the Chalk River isotope separator. The observed influence of temperature is marked. The median range for both ⟨100⟩ and ⟨110⟩ incidence is a factor of 2 greater at 20°K than at 295°K, and the depths beyond which 10^{-2}, 10^{-3}, and 10^{-4} of the particles travel are, correspondingly, up to a factor of 3 greater at 20°K. In these two directions, the range of the "perfectly" channeled particle varies with temperature consistently with the exponential dependence predicted by Lehmann and Leibfried (1963). At ⟨111⟩ incidence, little channeling appears to occur characteristic of this direction, even at 20°K; however, a few percent of the ions do have deep penetrations, arising, it is thought, from channeling skew to the ⟨111⟩. Perhaps surprisingly, the ⟨111⟩ distribution exhibits a strong temperature dependence, which is suggestive of a lattice effect with higher stopping power than in amorphous material. (auth) (Canada)

996 NUMERICAL DETERMINATION OF THE ABSORPTION COEFFICIENT OF THE NEGATIVE HYDROGEN ION. Krogdahl, Wasley S.; Miller, James E. (Univ. of Kentucky, Lexington). Astrophys. J., 150: 273-88(Oct. 1967).

A method is outlined for obtaining a numerical solution of the classical Schrödinger equation for two-electron atomic systems. The necessary equations for the S state are derived, and the boundary conditions are specified. The underlying principles are compared and contrasted with those of other general methods of attacking the problem. Sources of error and limitations of accuracy are considered, together with tests of the resultant wave functions. The method for obtaining numerical solutions of the two-electron problem is applied to the negative hydrogen ion. The asymptotic boundary values are given for a fourth-order approximation, and an energy of $E = -0.52775$ is used. The wave function which represents the solution of this boundary-value problem is tested by the virial theorem and the local energy value $(H\psi)/\psi$ is calculated. The wave function is then used to compute continuous absorption coefficients with a plane-wave free-state function. The results are compared with previous calculations that have derived the ground-state wave function by minimal principles. The sum-rule tests are applied to the results. (auth)

997 NOTE ON THE SIGNIFICANCE OF THE AHARONOV-BOHM EFFECT. Liebowitz, Benjamin. Z. Phys., 207: 20-3 (1967).

The fringe shift first predicted by Ehrenberg and Siday and subsequently more fully discussed by Aharonor and Bohm has been consistently explained in terms of a classical interaction energy arising from overlap of the electron's and solenoid's magnetic fields. Kasper criticizes this theory on the ground that "skin effect" would prevent penetration of the electron's magnetic field into the interior of the solenoid. This criticism is shown to be invalid. (auth)

998 ON THE EXCHANGE ENERGY IN AN SCF METHOD USING NONORTHOGONAL BASIS FUNCTIONS. Buti, Gy. (Research Group for Theoretical Physics, Budapest). Acta Phys. Acad. Sci. Hung., 23: 287-90(1967).

A method is developed for the calculation of exchange energy in a simple SCF method or atomic one-electron eigenfunctions using nonorthogonal basis functions. (auth)

999 THE RANGE OF 5- TO 50-keV HEAVY IONS IN VARIOUS GASES. Hughes, S. (United Kingdom Atomic Energy

Authority, Annan, Scotland). Phys. Med. Biol., 12: 565-71(Oct, 1967).

Extrapolated ionization ranges are presented for H^+ ions of energy 5 to 50 keV in the gases Ar, CO_2, N_2; these show good agreement with other measurements. Further preliminary measurements of ranges for H^+ ions of energy, 5 to 50 keV in CH_4, C_2H_2, C_2H_4, C_3H_8, C_4H_{10}, and for N^+ ions of energy 5 to 30 keV in CH_4, are presented with an accuracy of ±8%. Estimates of stopping cross sections of CH_4, C_2H_2, C_2H_4, C_3H_8, C_4H_{10} for H^+ ions, made from these data, have values in the range 20×10^{-15} ev cm^2 to 76×10^{-15} ev cm^2. (auth)

1000 SENSITIVE SPARK LINES OF EINSTEINIUM. Gutmacher, Ralph G.; Evans, James E.; Hulet, E. Kenneth (Univ. of California, Livermore). Contract W-7405-eng-48. J. Opt. Soc. Amer., 57: 1389-90(Nov. 1967). (UCRL-70468).

The first observation of spectral lines of einsteinium is reported. The einsteinium was synthesized by neutron irradiation of a mixture of curium isotopes and purified by ion exchange techniques. The spectra were recorded and a thorough search was made for lines of other elements. The wavelengths and relative intensities of the spectral lines finally attributed to Es are tabulated. The most persistent lines found are at 3547.72 and 3602.42 Å. These two lines and a line at 3669.92 Å show partially resolved hyperfine structure. (A.G.W.)

1001 IONIZATION BY FISSION FRAGMENTS ESCAPING FROM A SOURCE MEDIUM. Nguyen, Dong H. (Univ. of Texas, Austin); Grossman, Lawrence M. Nucl. Sci. Eng., 30: 233-41 (1967).

The space-dependent ion production rate by fission fragments escaping from a fuel plate is studied using: (1) the Bohr stopping equation with the Thomas–Fermi approximation of the effective charge Z_{eff}; (2) the Alexander–Gazdik (A–G) semiempirical velocity–distance relationship for fission fragments. The assumptions are: no scattering during slowing down; the nonionizing energy loss in nuclear recoils can be taken into account by increasing the w value for fission fragments over that for α particles; a delta-function mass distribution for the light and heavy group; and a monoenergetic source. The energy current carried by the fragments at a point in the outer medium is first derived, and the energy deposition per unit volume per second is obtained by taking the gradient of the energy current. Dividing the energy deposition by the w value for the medium yields the ion production rate by fission fragments in that medium. The results show that the semiempirical velocity–distance relationship gives a higher ion production rate than that given by the velocity–distance relationship derived from the Bohr stopping equation with the Thomas–Fermi approximation of the effective charge Z_{eff}. The volumetric, spatial average ion production rate is also obtained. For a fuel plate containing 20% ^{235}U and 80% Pt and for a flux of 6×10^{10} n/(cm^2 sec), the velocity–distance relationship based on the Bohr stopping equation gives an average ion production rate of 2.0×10^{13} ion pairs/(cm^3 sec) in a mixture Ne + 0.1% Ag. Using the same values for the fragment ranges, the semiempirical velocity–distance relationship yields an average volumetric ion production rate in Ne higher by about 18% for the light fragment and by about 20% for the heavy fragment. According to existing experimental results on plasmas induced by fission fragments, an ion source of 2.0×10^{13} ion pairs/(cm^3 sec) would yield a conductivity of about 1×10^{-3} $(\Omega m)^{-1}$ in the gas mixture Ne + 0.1% Ag, at 200-mm Hg and 400°K and at an electric field of 560V/m. (auth)

1002 ANALYSIS OF THE SPECTRUM OF TRIPLY IONIZED MANGANESE (Mn IV). Yarosewick, Stanley J.; Moore, Frank L. Jr. (Clarkson Coll. of Tech., Potsdam, N. Y.). J. Opt. Soc. Amer., 57: 1381-7(Nov. 1967).

The fourth spectrum of manganese was investigated from 500 to 2500 Å with two-meter normal-incidence vacuum spectrographs. The wavelengths of the spectral lines, excited in both sliding-spark and condensed-spark discharges in helium, were determined with an uncertainty of ±0.006 Å. Forty-seven new energy levels belonging to sixteen terms were found, and the whole term system was recalculated on the basis of the new measurements. Four hundred and twenty-eight spectral lines were classified as transitions between levels of the $3d^3$, $3d^24s$, and $3d^24d$ configurations and levels of the $3d^24p$ configuration. (auth)

1003 SINGLE-PARTICLE SPECTRUM OF THE DEGENERATE ELECTRON GAS. II. NUMERICAL RESULTS FOR ELECTRONS COUPLED TO PLASMONS. Lundqvist, B. I. (Inst. of Theoretical Physics, Goteborg). Phys. Kondens. Mater., 6: 206-17(1967).

The single-particle spectrum of an interacting electron gas is investigated in an approximation with electrons coupled to plasmons. Extensive numerical results for the spectral weight function, the momentum distribution function and the density of states are presented over a range of metallic densities. (auth)

1004 SINGLE-PARTICLE SPECTRUM OF THE DEGENERATE ELECTRON GAS. I. THE STRUCTURE OF THE SPECTRAL WEIGHT FUNCTION. Lundqvist, B. I. (Inst. of Theoretical Physics, Goteborg). Phys. Kondens. Mater., 6: 193-205(1967).

The single-particle spectrum of an interacting electron gas is discussed. There is a characteristic structure in the spectral weight function at energies that differ from the quasi-particle energy by energies of the order of the plasma energy. This structure is due to the singular Coulomb potential and the plasmon part of the effective interaction at long wavelengths. For momenta deep inside the Fermi sea a new elementary excitation of appreciable strength appears. It can be interpreted as a coupled mode of holes and plasmons. (auth)

1005 THE TRAPPING OF HYDROGEN IONS IN MOLYBDENUM, TITANIUM, TANTALUM, AND ZIRCONIUM. McCracken, G. M.; Maple, J. H. C. (United Kingdom Atomic Energy Authority, Abingdon, Eng.). Brit. J. Appl. Phys., 18: 919-30(July 1967).

The trapping of hydrogen ions in molybdenum, titanium, tantalum and zirconium was measured by a mass-spectrometric technique. Targets were bombarded by a mass-analyzed ion beam of 10 to 100 μA at 3 to 30 kεV in a target chamber at about 1 ntorr. The rise in partial pressure of hydrogen in the target chamber was measured during bombardment and subsequently during thermal desorption. The absolute trapping efficiency was then calculated from these two measurements. The trapping efficiencies were measured as a function of ion dose and energy. It was found that Mo has initially a high trapping efficiency, but that the trapping efficiency rapidly decreases with dose and saturation is reached at about 10^{17} ions/cm^2 at room temperature. Ti, Ta, and Zr exhibit markedly different behaviour. Trapping efficiencies as high as 0.92 are observed and these are maintained constant with dose up to the maximum so far used of nearly 10^{19} ions/cm^2. No appreciable variation of the trapping efficiency with energy was observed in the range investigated. These results are interpeted in terms of a model which takes into account the diffusion coefficient of hydrogen in the metal and the potential barrier to hydrogen atoms at the surface. (auth) (UK)

1006 CALCULATED RAMSAUER–TOWNSEND EFFECT IN ^4He–^4He COLLISIONS. Aldridge, J. P.; Davis, R. H. (Florida State Univ., Tallahassee). Phys. Rev. Lett., 19: 1001-2(Oct. 30, 1967).

It is pointed out that at low bombarding energies the conditions for an atomic Ramsauer–Townsend effect are satisfied in collisions between neutral He atoms. The Phillipson–Morse–Dalgarno (PMD) potential is assumed to describe the interaction. The total cross section and phase shifts for l = 0, 2, and 4 partial waves are plotted as functions of center-of-mass energy in MeV. A sharp dip in the total cross section at 0.16 MeV is associated with the passage of δ_0 through 0°, and the other phase shifts are small. Finite contributions from the second and fourth partial waves prevent the cross section from reaching zero. A temperature scale determined by $kT = E_{c.m.}$ is shown, and the value of T corresponding to $\delta_0 = 0°$ is 2.2°K. The minimum in the total cross section is ~2.0°K. (A.G.W.)

1007 PIONIC AND MUONIC X RAYS IN LIQUID HELIUM. Wetmore, R. J.; Buckle, D. C.; Kane, J. R.; Siegel, R. T. (College of William and Mary, Williamsburg, Va.). Phys. Rev. Lett., 19: 1003-5(Oct. 30, 1967).

The K-series lines resulting from entry of a 200-MeV/c pion–muon beam into a liquid-helium scintillation counter were observed. The spectra show clear separation of K_α and K_β peaks for both pions and muons and evidence for K_γ and perhaps higher transitions on the upper sides of the K_β lines. Evidence of muonic contamination of the pion spectrum appears at x-ray energies below the He π–K_α position. Energies and widths of the observed lines are compared with calculated energies. (A.G.W.)

1008 RELATIVE INTENSITIES OF K AND L SERIES OF MUONIC X RAYS. Suzuki, Arata (Carnegie-Melion Univ., Pittsburgh). Phys. Rev. Lett., 19: 1005-9(Oct. 30, 1967).

Relative intensities of muonic x rays have been measured for the K series of Ca, S, Si, and Mg and L series of Ca. K_α yields of all the elements are about 80% of the total K lines. The relative intensities of Ca K_γ, K_δ, K_ϵ, and K_ζ x rays are almost constant and are about 2% of the total K lines. A statistical initial distribution of muons in a high-n state might be sufficient to explain the data if electron stripping effects are included in the calculations. (auth)

1009 VERY LONG NUCLEAR SPIN RELAXATION TIMES IN GASEOUS ^3He BY SUPPRESSION OF ^3He–SURFACE INTER-

ACTIONS. Fitzsimmons, W. A.; Walters, G. K. (Rice Univ., Houston, Tex.). Contract AT(40-1)-1316. Phys. Rev. Lett., 19: 943-6(Oct. 23, 1967). (ORO-1316-50).

Experiments are described that reveal the nature of the surface relaxation mechanisms between ^{3}He atoms and their containing walls and effective means for their suppression. The resultant very long ^{3}He relaxation times (>2 × 10^5 sec at 300°K, and rising rapidly with temperature) measured in highly spin-polarized samples prepared by optical pumping offer new possibilities for high-density polarized ^{3}He nuclear targets, and for experiments requiring near-perfect gyroscopes. (auth)

1010 CHARGE-TRANSFER SCATTERING OF H^+ ON Kr IN THE 70 TO 200-eV RANGE. Fleischmann, Hans H.; Young, Robin A. (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Phys. Rev. Lett., 19: 941-3(Oct. 23, 1967).

Some structure in the differential charge-transfer cross section of H^+ + Kr was found. From basic similarities with comparable differential cross sections for elastic scattering, molecular curve crossings are suggested as the cause. (auth)

1011 ENERGY DEPENDENCE OF H(2s) PRODUCTION IN PROTON–ALKALI COLLISIONS FROM 2 TO 30 keV. Sellin, I. A.; Granoff, L. (New York Univ., N. Y.). Phys. Lett., 25A: 484-5(Sept. 25, 1967).

Relative cross sections for production of H(2s) in collisions with Cs, Rb, and K have been measured. Their energy dependence is compared with calculations of Rapp and Francis and of McElroy. (auth)

1012 STUDIES OF THE DYNAMICAL BEHAVIOR OF ADSORBED MOLECULES BY SLOW NEUTRON SPECTROMETRY. Verdan, G. (EURATOM, Ispra, Italy). Phys. Lett., 25A: 435-6(Sept. 25, 1967).

The scattering of cold neutrons from H_2, CH_4, C_2H_4, and C_2H_2 adsorbed on activated charcoal was measured at low temperatures. The time-of-flight spectra of the scattered neutrons reveal the dynamical behavior of the adsorbed molecules. (auth)

1013 SPUTTERING OF A (100) COPPER FACE BOMBARDED BY 34 TO 80 keV ARGON IONS AS A FUNCTION OF THE ANGLE OF INCIDENCE. Drentje, S. A. (Natuurkundig Laboratorium, Groningen, Netherlands). Phys. Lett., 25A: 433-5(Sept. 25, 1967).

The change of the total sputtering yield S of a (100) copper face with angle of incidence Ψ of the bombarding argon ions (energy 34 to 80 keV) has been measured with Weijsenfeld's method. The widths of minima in $S(\Psi)$ curves show an energy dependence $\propto E^{-1/4}$, in accordance with theory. (auth)

1014 REMARKS ON THE RELATIONSHIP BETWEEN ELECTRON INTERFERENCE AND ELECTRON POLARIZATION. Farago, P. S. (Univ. of Edinburgh). Ann. Phys. (Leipzig), 20: 71-6(1967).

In relation to a recent paper by Inthoff, it is pointed out that it is legitimate to describe the polarization accompanying the interference of electron beams as resulting from the spin dependence of the wavelength of the electrons while they are in an electromagnetic field. Using a semi-classical argument it is shown furthermore that an electron optic "biprism" would give a detectable polarization effect only if on account of its very high gradient the field constituting the biprism could not be considered constant over a region whose linear dimensions are comparable with the Compton wave length of the electron. (auth)

1015 ON THE MAGNETIC FIELD DEPENDENCE OF THE TRANSPORT PROPERTIES OF THE HYDROGEN ISOTOPIC MOLECULES H_2, D_2, AND HD. Tip, A. (FOM-Instituut voor Atoom en Molecuulfysica, Amsterdam). Phys. Lett., 25A: 409-10 (Sept. 25, 1967).

Theoretical expressions are given which describe the magnetic field dependence of the heat conductivity and viscosity of hydrogen isotopic molecules. From the combined experimental results on both transport properties the relative importance of translational and rotational contributions to the field influence on the heat conductivity is estimated. (auth)

1016 EXCITATION OF INERT GASES AT ELECTRON–ATOM COLLISIONS. IV. KRYPTON. Fel'tsan, P. V. (Uzhgorod State Univ., USSR). Ukr. Fiz. Zh., 12: 1425-31(Sept. 1967). (In Russian).

The results are presented of experimental studies of effective cross sections and excitation functions of 33 krypton spectral lines, corresponding to the transitions $4p^55p$ $4p^55s$ and $4p^66p$ $4p^55s$, at the collisions with low energy electrons. The measurements were carried out under conditions when the intensity changed with krypton pressure and current density, the dependence being linear, and energetic nonuniformity of the beam electrons under operating conditions did not surpass 1.2 eV. A variety of excitation functions of krypton lines is detected. Some of the functions have two maxima. The data of the investigation of excitation lines are applied to determine the excitation cross sections of 10 levels. Their values are within the range of (3.12 to 3.25) × 10^{-17} cm^2. (auth)

1017 RADIO FREQUENCY TIME-RESOLVED SPECTROSCOPY: A MEASUREMENT OF THE LAMB SHIFT AT THE n = 4 LEVEL IN IONIZED HELIUM. Hatfield, Lynn LaMar. Fayetteville, Ark., Univ., of Arkansas, 1967. 99p.

A novel method that should be generally useful in rf spectroscopy between two states having different lifetimes has been developed and used to measure the Lamb shift in the n = 4 level of He^+ ($4^2S_{1/2} - 4^2P_{1/2}$ energy difference). The method is based on the sampling technique of Pendleton and Hughes for determining atomic lifetimes. The Lamb shift is measured by applying the sampling technique to the n = 4 level in He^+. Since the 4s lifetime is considerably longer than any other n = 4 state lifetime, radiation from the 4s decay can be isolated from the decay of the other states by waiting a sufficiently long time after the initial population of the n = 4 states. A gated beam of 300-eV electrons is used to excite the n = 4 level of He^+ by simultaneous ionization and excitation. The λ4686Å (n = 4 — 3) radiation is monitored with the sampling oscilloscope set to sample 20 nsec after beam cut off so that only 4s — 3p decay is present. The loss in 4s — 3p radiation is then a measure of the net $4^2S_{1/2} - 4^2P_{1/2}$ stimulation. The electron gun assembly is attached to the side of a wave guide placed between the pole faces of an electromagnet. The magnetic field is changed to bring the s and p Zeeman states in and out of resonance with the rf radiation. This allows fixed-frequency operation of the rf source. The rf is gated on for alternate electron-beam pulses. The sampling oscilloscope has been modified to make the two identical vertical channels sample alternately. The photomultiplier output is connected to both channels. The oscilloscope output from the channel that samples when the rf is off is used to regulate the electron-beam current. The output from the channel that samples when the rf is on is recorded as a function of magnetic strength. The lifetime of the 4s state in He^+, determined from the averaged results of thirteen independent measurements, is (1.3$_6$ ± 0.2$_5$) × 10^{-8} sec. This agrees with the theoretical value of 1.4154 × 10^{-8} sec. The Lamb shift is determined by finding the magnetic field strength corresponding to the center of the absorption curve. The averaged result of eleven independent measurements is (1766.0 ± 7.53) MHz. This agrees with the best available theoretical value, (1768.2 ± 0.6) MHz. (TSS) (Disser. Abstr.)

1018 INELASTIC COLLISIONS OF THE SECOND KIND BETWEEN ELECTRONS AND EXCITED MERCURY ATOMS. Burrow, Paul David. Berkeley, Calif., Univ. of California, 1966. 64p.

Thesis.

The relative cross section for inelastic collisions of the second kind between electrons and mercury atoms in the excited $^3P_1$ state was measured as a function of electron energy. Excited atoms were produced by absorption of the 2537-Å resonance radiation from a mercury arc. A low-energy beam of electrons with good resolution was produced by using the retarding potential difference method. Electrons that made collisions with excited atoms could gain kinetic energy by leaving the atoms in the ground state. These faster electrons were detected by passing them through a potential barrier that reflected unscattered electrons. The data are in good agreement with the cross section computed by applying detailed balancing to the known cross section for excitation to the $^3P_1$ state by electron impact. Information about the angular scattering dependence was also obtained. A brief discussion is given concerning the structure in the cross section due to temporary negative ion formation. (Disser. Abstr.)

Cosmic Radiation

Refer also to abstracts 308, 316, 364, 365, 789, and 833–835.

1019 (JINR–P2-3507) K RASCHETU NEUPRUGIKH VZAIMODEISTVII KOSMICHESKIKH YADER. (On the Calculation of Inelastic Interactions of Cosmic Nuclei). Barashenkov, V. S.; Gudima, K. K.; Toneev, B. D. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1967. 6p. (In Russian). Dep.

The results of cascade calculations of deuteron and α-particle interactions with nuclei at high energies are discussed. (auth)

1020 (TT-67-51365) COSMIC RAYS AND PROBLEMS OF SPACE PHYSICS. Proceedings of the All-Union Conference on the Space Physics Aspects of Cosmic-Ray Research, Yakutsk,

August–September 1962. Shafer, Yu. G. (ed.). Translation of Kosm. Luchi. Probl. Kosmofiz., Akad. Nauk SSSR, Sib. Otd., Tr. Pervogo Vses. Soveshch., Yakutsk, 1962, 1-296(1965). 311p. (IPST-Cat.-1814; NASA-TT-F-428). Dep. CFSTI.

An abstract of the conference proceedings in Russian from which this translation was made appeared in NSA as abstract 19: 37510. (A.G.W.)

1021 SOLAR COSMIC-RAY ACTIVITY. Masley, A. J. (Douglas Aircraft Co., Santa Monica, Calif.). Antarctic J. U. S., 2: 175-6(Sept.-Oct. 1967).

A significant increase in solar cosmic-ray activity began in early 1966. From March 1966 to June 1967, 14 events were observed. The distribution of events from 1962 to early 1967, with the variation in the smoothed sunspot number, is shown. The maximum absorption in decibels for 30 MHz is shown also. The abrupt increase in solar cosmic-ray activity from the time of the last solar minimum to the present is illustrated. Data on the 14 events observed by riometers at McMurdo Station, Antarctica, and Shepherd Bay, Canada, in 1966 and early 1967 are tabulated. The maximum absorption in decibels at 30 MHz for each event, solar information, and the delay time from the beginning of the flare to the observation of absorption are indicated. (J.H.M.)

1022 INVESTIGATIONS OF COSMIC-RAY INTENSITY VARIATIONS IN ANTARCTICA. Pomerantz, Martin A. (Franklin Inst., Swarthmore, Pa.). Antarctic J. U. S., 2: 170-1(Sept.-Oct. 1967).

Due to the role played by the geomagnetic field in determining the "optics" of cosmic-ray detectors, it is possible to view directions of arrival of particles significantly inclined to the ecliptic plane only in the polar regions. Thus, observations made with continuously recording neutron monitors at fixed locations in the Arctic and Antarctic afford a unique means for investigating anisotropies that may arise in a direction perpendicular to the equatorial plane. Information is included on recordings from a network of neutron monitors during the recovery phase of a Forbush decrease in March 1966 and the detection of solar cosmic particles during solar events of July 7, 1966, and January 28, 1967. Plotted data show the percent deviation of cosmic-ray absorption during the event of January 28, 1967. (J.H.M.)

1023 PERIODICAL FLUCTUATION STUDIES OF COSMIC-RAY DIURNAL VARIATIONS DURING THE QUIET-SUN PERIOD 1962–64. Kodama, Masahiro (Chalk River Nuclear Labs., Ont.). Can. J. Phys., 45: 2733-48(Aug. 1967). (AECL-2923).

Statistical studies of periodic fluctuations of the cosmic-ray diurnal variation have been performed, using neutron and meson component data obtained by the high-counting-rate cosmic-ray monitors at Deep River. The data cover an interval from May 1962 to October 1964, a period of descending solar activity ending near the solar minimum. It is shown that a 27-day recurrence tendency of the amplitude of the diurnal variation occasionally appears as well as shorter recurrent variations, ranging from one-half to one-sixth of the solar rotation period. The correlations of these fluctuations with some typical solar and terrestrial indices are examined in order to search for possible origins of the shorter recurrent variations. A possible connection with the K_p index exists. (auth) (Canada)

1024 INCREASE EFFECTS AND ANOMALOUS DAILY VARIATION DURING COSMIC-RAY STORMS. Lindgren, S.; Pak, Byong-So (Uppsala Univ.). Ark. Fys., 5: 283-304(1967).

An analysis of some storm-time increases, essentially those of August 17–18, 1958 and April 18, 1965, seems to indicate the following features: (1) a rise of the intensity level, averaged over 24 hours, so that, in extreme cases, stations in most sensitive latitude bands feel no modulation at all when polar stations see a decrease; (2) coinciding with the maximum depression of the geomagnetic field a much stronger increase lasting for a few hours (the proper storm-time increase) and at least in some cases extending to polar latitudes; (3) possibly an asymmetric effect lasting for a few days and causing a larger flow from the evening hemisphere; and (4) possibly a discontinuity is this asymmetric component, located near the antisolar direction. A remarkable example of cosmic-ray streaming from the morning hemisphere was observed after the larger Forbush decrease of July 13, 1961. During two days the peak to peak amplitude was no less than 3 to 6 per cent whereas the direction gradually shifted from the solar direction to very early morning directions. Four other cases of anomalous streaming are reported, all of them closely related to cosmic-ray storms. (auth) (SWEDEN)

1025 CHARGE SPECTRUM OF VERY HEAVY COSMIC-RAY NUCLEI. Fowler, P. H.; Adams, R. A.; Cowen, V. G.; Kidd, J. M. (Univ. of Bristol, Eng.). Proc. Roy. Soc. (London), Ser. A, 301: 39-45(Oct. 3, 1967).

Several examples of highly charged ($Z > 40$) cosmic-ray primaries were observed in a photographic emulsion detector of area 4.5 m^2. The detector was flown by balloon over Texas, where the geomagnetic cutoff ensures that all primaries are relativistic at the top of the atmosphere. Approximately 2×10^5 tracks of cosmic-ray primaries with charge $Z > 20$ were observed. Among these were found nine outstandingly heavy tracks which penetrated the entire assembly without measurable change of track density. This shows that the range of each track was in excess of ~6 g/cm^2; these tracks, therefore, could not have been produced by slow iron nuclei. The two heaviest tracks detected had a charge of 90 ± 4, which suggests that the source is relatively rich in elements which have been formed by rapid neutron synthesis—the "r" process. (auth) (UK)

Direct Energy Conversion

Refer also to abstract 1350.

1026 (AD-646740) THE EFFECTS OF PARTIAL CONDENSATION AROUND IONS IN ELECTRIC FLUID DYNAMIC ENERGY CONVERSION PROCESSES. Final Report, October 1963–March 1964. Decaire, John A. (Aerospace Research Labs., Wright-Patterson AFB, Ohio). Sept. 1966. 57p. (ARL-66-0187). CFSTI.

Thesis.

Fluid dynamic energy is converted directly into electrical energy—unipolar charges are seeded into a gas flow and are transported by viscous interaction with the gas molecules to an electrode of high potential. The effectiveness of the viscous coupling depends on the charge mobility being greatly increased when colloid sized particles rather than molecular ions are used as the charge carriers. The mobility of charged colloids is discussed theoretically. Negative ions are produced by a corona discharge from a needle placed along the axis of a nozzle. A dense air–vapor mixture is expanded through the nozzle. The vapor condenses around the ions forming charged droplets. Water and carbon tetrachloride vapors are tested. The current and power outputs of the test generator are greatly increased over the corresponding performance when ions are the charge carriers—current increases are about a factor 4 and power increases about one order of magnitude. The observed results are in good agreement with the theory. (auth)

1027 ION-CURRENT AND SCHOTTKY EFFECTS IN THERMIONIC DIODES. Hansen, L. K. (Atomics International, Canoga Park, Calif.). J. Appl. Phys., 38: 4345-54(Oct. 1967).

An experimental and theoretical study is made of current nonsaturation phenomena in cesium vapor, thermionic diodes. It is shown that ion flow from the plasma to the emitter electrode produces a significant nonsaturation effect. It is also shown that this ion current produces a high-sheath field at the emitter which accentuates the nonsaturation through the Schottky and anomalous Schottky effects. These effects are incorporated into an analysis of diode behavior. It is shown that the expected diode behavior due to ion-current and Schottky effects is consistent with available experimental data. (auth)

1028 ABOUT THE THEORY OF MHD CONVERTERS WITH RECTANGULAR CHANNELS. Weh, H. (Technische Hochschule, Brunswick). Atompraxis, 13: 407-12(1967). (In German).

Based on the vector potential the fundamental partial differential equation of MHD converters is reviewed. Owing to the finite conductivity of the flank conductor, the flow of the current does not stream through the converter channel rectilinearly. The effects of the finite width of a converter and the influence of the side conductor materials are discussed. The additional losses and field distortions caused by the higher and subharmonics that are a consequence of the winding design are described. The effects of nonuniform velocity distribution in rectangular channels are sketched. An improved physical model in which the permeance of the air regions beyond the winding zones is made a fraction of the latter is used to calculate losses caused by the compensating waves. Tests carried out on a model consisting of an induction motor with a stator winding only around two-thirds of the bore, and in which the teeth on the unwound third of the bore are removed, correspond well with theoretical calculations. (auth)

1029 THERMOELECTRIC GENERATORS. Wartanowicz, Tomasz. Mech. Teor. Stosow., 4: No. 3, 27-40(1966). (In Polish).

A survey was made of the development of thermoelectric generators. It describes present capabilities in the design of thermoelectric generators (such as the SNAP series—SNAPs 3, 9, 10, and 10A) and thermoelectric materials. Possible practical

applications of these energy sources are examined, and the thermoelectrochemical generator is described. (IAA)

Fluid Physics

Refer also to abstracts 1026, 1205, 1236, and 1516.

1030 (AD-646589) INVESTIGATION OF ELECTRIC ARC INTERACTION WITH AERODYNAMIC AND MAGNETIC FIELDS. Final Scientific Report. Roman, W. C.; Myers, T. W. (Aerospace Research Labs., Wright-Patterson AFB, Ohio). Sept. 1966. 70p. (ARL-66-0191). CFSTI.

An experimental study of a balanced electric arc of 200 to 400 amperes in an atmospheric pressure cross-flow air stream of velocities up to 60 ft/sec and transverse magnetic field strengths up to 50 gauss was made. An open-jet-type facility permitted the use of diagnostic techniques in the arc wake region. The arc's significant dimension transverse and parallel to the flow was measured. This dimension increased transverse to the flow and decreased parallel to the flow as the transverse blowing velocity was increased. Velocity profiles, energy flux distributions, relative turbulence levels and frequency measurements were obtained in the arc wake using miniaturized probe techniques. Flow visualization studies were performed using micron-sized particles. The input and output arc power distribution was obtained. The energy convectively transferred to the arc wake was equal to the additional electrical energy input required to maintain the arc in the presence of the transverse blowing. A drag coefficient for the arc, analogous to that of a solid cylinder subjected to a cross-flow, was defined and measured to have values between 0.7 and 1.2. Comparisons between the wake of an arc and that of a heated solid cylinder indicated similarity in vortex shedding frequency and convective heat transfer. (auth)

1031 (AD-648087) DISCONTINUITY RELATIONS AND SHOCK POLARS FOR CONSERVATION EQUATIONS, WITH APPLICATION TO MAGNETOGASDYNAMICS. Geffen, Nima (Technion-Israel Inst. of Tech., Haifa. Dept. of Aeronautical Engineering). Aug. 1966. Contract AF-EOAR-83-65. 36p. (TAE-57). CFSTI.

A simple procedure to obtain relations across discontinuities in nondissipative continuum physics is described. The discontinuity conditions are derived from the differential set expressing the physical conservation laws, possibly with source terms, in arbitrary coordinate systems, and in any desired form. This procedure differs from other ways to derive discontinuity or shock relations, in (a) the presence of a source term or forcing function, and (b) that it does not involve the vector-shock geometry, and is closely tied in with the formulation of the continuous part of the field. Thus, it is convenient for the solution of nonlinear boundary value problems, where discontinuities may occur. It was also found suitable for a very easy derivation of approximate magnetogasdynamic shock relations, and for numerical calculations of nonlinear flows. Nonaligned magnetogasdynamic shock relations and polars are derived, and various limiting cases are discussed. (auth)

1032 (AD-648250) ON THE USE OF VARIATIONAL METHODS IN STEADY MAGNETOGASDYNAMICS. Cap, F.; Mueller, G. (Innsbruck Univ. (Austria). Institut fuer Theoretische Physik). Nov. 21, 1966. Contract AF61(052)-675. 18p. (AFOSR-67-0416.). CFSTI.

After having shown under which conditions the derivation of a potential equation is possible in magnetogasdynamics, the derivation is discussed. Since there is a change of type at the transit from the subcritical range to the supercritical one, the variational method is the only possibility to obtain a homogeneous solution for both ranges. The variational problem which belongs to the potential equation is discussed and solved for a ratio of the specific heats of 1.5 for the flow past a cylinder. The two figures show the flow lines and the lines of the same Mach number for a cylinder with the radius of 1 m, a magnetic field of 10,000 gauss and an initial flow velocity of 500 m/sec. (auth)

1033 (JPRS-42454) SOVIET EXPERIMENTAL POWER PLANT WITH A MAGNETOHYDRODYNAMIC GENERATOR. Orlov, Vladimir. Translated from Nauka Zhizn, 33: No. 6, 2-7 (1967). 11p. (TT-67-33083). CFSTI.

A popular review of an experimental magnetohydrodynamic generator power plant is given. (W.D.M.)

1034 STEADY TWO-DIMENSIONAL MAGNETOHYDRODYNAMIC FLOW. II. Gundersen, Roy M. (Univ. of Wisconsin-Milwaukee, Milwaukee). Z. Angew. Math. Phys., 18: 661-71 (Sept. 25, 1967).

Previously, the equations which govern the two-dimensional, steady flow of an ideal, inviscid, perfectly conducting compressible fluid were discussed for the three possible cases in which the applied magnetic field had but one nonzero component (Z. Angew. Phys., 17: 755(1966)). Here, these three cases are re-examined, and the restriction of total hyperbolicity is removed. In each of the three cases, it is possible to define a perturbation stream function, which satisfies a linear second-order partial differential equation; this differential equation is affinely equivalent to either an inhomogeneous wave equation or Laplace's or Poisson's equation, depending upon the relative magnitudes of the flow parameters. (M.H.R.)

1035 USE OF VARIATIONAL METHODS IN STEADY MAGNETOGASDYNAMICS. Cap, F.; Mueller, G. (Univ., Innsbruck). Z. Angew. Math. Phys., 18: 672-82(Sept. 25, 1967).

After having shown under which conditions the derivation of a potential equation is possible in magnetogasdynamics, this derivation is discussed. Since there is a change of type at the transition from the subcritical range to the supercritical one, the variational method is the only possibility to obtain a homogeneous solution for both ranges. The variational problem which belongs to the potential equation is deduced and solved with $k = 1.5$ for the flow past a cylinder. The two figures show the flow lines and the lines of the same Mach number for a cylinder with the radius $R = 1$ m and a magnetic field $H = 10{,}000$ G and an initial flow velocity $U = 500$ m/sec. (auth)

1036 HYDROMAGNETIC SURFACE WAVES IN A CONDUCTING LIQUID SURROUNDED BY A COMPRESSIBLE GAS. Gerwin, Richard (Boeing Scientific Research Labs., Seattle). Phys. Fluids, 10: 2164-70(Oct. 1967).

Those surface waves are studied that can propagate along a plane interface separating a conducting (incompressible) liquid from a nonconducting, compressible gas, when there is a static magnetic field parallel to the interface. For any given direction of propagation along the surface (except exactly perpendicular to the magnetic lines), and with the gas mass density small compared to that of the liquid, we find an approximate critical magnetic field strength above which the usual surface Alfvén waves cannot exist. Instead, at these strong magnetic fields, there are surface sound waves in the gas. The critical magnetic field at which the (actually smooth) transition from Alfvén-type to sound-type surface waves takes place is practically independent of the gas density, depending essentially only on its temperature. (auth)

1037 RECENT DEVELOPMENTS IN OPEN-CYCLE MHD POWER SYSTEMS. Moszynski, Jerzy (Univ. of Delaware, Newark). Power Reactor Technol. Reactor Fuel Process., 10: 20-6(Winter 1966-67).

This article, a sequel to that reviewed (Power Reactor Technology, 8(4): 190-209(Fall 1965)) further summarizes open-cycle MHD technology as it emerges from the Salzburg symposium (1966). Topics reviewed include: operating experience; high-temperature materials developments; component design problems; basic combustion plasma physics; and the direction of future progress as indicated by developing programs, analytical studies, and novel ideas. (auth)

1038 MAGNETOHYDRODYNAMICS OF LIQUID FILMS FLOWING ALONG A VERTICAL PLANE SURFACE. Agarwal, J. P. (Indian Inst. of Tech., Kharagpur). A.I.Ch.E. (Amer. Inst. Chem. Eng.) J., 13: 1030-1(Sept. 1967).

Numerical expressions are given for the magnetohydrodynamics of a draining liquid film. The calculations include the solution of an equation of fluid flow past a vertical plane surface in the presence of a magnetic field. (J.H.M.)

1039 ROLE OF ELECTRODYNAMICS IN TRANSPORT PHENOMENA. Bopp, G. R. (Univ. of Idaho, Moscow). Chem. Eng. Progr., 63: No. 10, 74-9(Oct. 1967).

Basic equations of electrodynamics are presented and several examples of systems involving electric and/or magnetic fields coupled with fluid velocity fields are given. The examples are presented for the purpose of illustrating the potential role of electrodynamics in transport phenomena. (J.H.M.)

1040 RELATIVISTIC HYDRODYNAMICS AND MAGNETOHYDRODYNAMICS. Lectures on the Existence of Solutions. Lichnerowicz, Andre. The Mathematical Physics Monograph Series. New York, W. A. Benjamin, Inc., 1967. 205p.

An introductory survey of the Leray theorems on hyperbolic partial derivative systems is given. Main applications are given to charged fluids with a null conductivity, and to the case of magnetohydrodynamics. Included is the first known existence theorem for the equations of magnetohydrodynamics. There is also a new approach to the theory of shock waves, as well as a report on new results in this field. (W.D.M.)

1041 GENERAL STAGNATION-POINT FLOW IN HYDRODYNAMICS AND IN MAGNETOHYDRODYNAMICS. Boger, Robert Carl. Ithaca, N. Y., Cornell Univ., 1967. 117p.
Thesis.

The inviscid, three-dimensional, stagnation-point flow near the front of a blunt body is investigated in full generality first in the ordinary hydrodynamic (OHD.) case, and second for magnetohydrodynamics (MHD.). An analytical method is developed for solution to any desired accuracy in distance from the stagnation point, and it shows that the previously accepted "exact" solutions are usually incorrect. The OHD. analysis is begun by assuming the velocities can be expanded as power series in the coordinates x and y parallel to the body, while allowing general functional behavior in the normal coordinate, z, for the coefficient functions of all x,y-terms. (The u and v velocities parallel the body.) The result of substituting these velocities into the equations of motion is a hierarchy of nonlinear ordinary differential equations, which may be separated into sets associated with the coefficient functions of the zeroth, first, second, etc. degree terms of x and y in u and v. By utilizing just the given information of initial values on the body, the solution is started to lowest accuracy in the lowest set of the hierarchy. Already at this first step the essential features of OHD. flow stand out. There is just one parameter, α_0, for OHD. flow and it characterizes the streamline pattern on the body. The stretching of vortex lines leads to a behavior $z^{(1-\alpha_0)/2}$ in velocity, so that the only physically relevant flows contain a nodal streamline pattern, $0 \leq \alpha_0 < 1$, or a stagnation line, $\alpha_0 = 1$. A method of regressive improvement of the approximation for the nodal case is then developed which implies that the solution may be found to any desired accuracy in distance from the stagnation point. The specific goal of accuracy up to, but not including, quadratic terms in x, y, and z requires that all coefficient functions and their associated sets of equations up to degree $4/(1-\alpha_0)$ be considered. This disallows previous "exact" solutions. The effect of surface curvature is shown not to alter the essential features presented. An inconclusive analysis is made for the stagnation line case, $\alpha_0 = 1$. This case is left unresolved. For the MHD. analysis the non-constant electromagnetic field is taken to be of the same form previously assumed for the velocities. The MHD equations of motion become a hierarchy of nonlinear ordinary differential equation substantially more complicated than in OHD., when the assumed velocities and fields are substituted. Once again utilizing only the initial values on the body the solution is begun, and the essential features of MHD. flow appear. There are two parameters specifying the MHD. flow. The first, Δ, characterizes the streamline pattern on the body, and plays the same role as the single parameter, α_0, did in OHD. The second parameter, Nn^2, measures the influence of the component of magnetic field normal to the body at the stagnation point. The nonanalytic velocity has leading behavior z^{ϵ_1}, where $\epsilon_1 = \frac{1}{2}(1 - \sqrt{\Delta}) + Nn^2$. Again the only relevant flows are when $0 \leq \Delta < 1$, the nodal streamline pattern, and $\Delta = 1$, the stagnation line. A method of regressive improvement such as developed for OHD. is again possible, so that the solution may be pursued to arbitrary accuracy. (Disser. Abstr.)

Geophysics

Refer also to abstract 1275.

1042 (AD-648675) A STUDY OF THE MECHANISMS OF WHISTLER PROPAGATION AND VLF EMISSION GENERATION. Final Report. Helliwell, R. A. (Stanford Univ., Calif. Stanford Electronics Labs.). Jan. 1967. Contract AF-AFOSR-783-66. 15p. (AFOSR-67-0461). CFSTI.

The review is organized under three main topics: (1) properties of the magnetosphere, (2) propagation and detection studies, and (3) wave–particle interactions. Using whistlers, plasma drift motion was detected in the magnetoshpere for the first time, and this has been interpreted in terms of a magnetospheric electric field with a westward component of about 0.3 mV/m at an equatorial distance of 4 earth radii. The upper cutoff frequency of whistlers was found to be remarkably close to $\frac{1}{2}$ the minimum gyrofrequency along the field-line path, providing strong evidence in support of the 'duct' cutoff theory of R. L. Smith. A sudden cutoff of whistler-mode signals was found at latitudes above the plasmapause. Research on wave–particle interaction theory has shown that previous theories have neglected the transient effects which are of importance in the interaction of whistlers with the medium. These results suggest that present theory on wave–particle interactions may be inapplicable to much of the whistler and discrete vlf emission phenomena. (auth) (TAB)

1043 (MPI-PAE-EXTRATERR.-16/65) MODELLRECHNUNG ZUR GEOMETRISCHEN GESTALT DER GRENZFLAECHE DER MAGNETOSPHAERE. (Model Calculation for Determination of Geometric Shape of Boundary Surface of Magnetosphere). Philipp, W. (Max-Planck-Institut fuer Physik und Astrophysik, Munich (West Germany)). July 1965. 71p. (In German). Dep. CFSTI.

In order to determine the geometrical shape of the outer boundary of the magnetoshpere, models with simplified physical assumptions have been considered by several authors. Some typical examples are discussed, and the influence of thermal agitation of plasma particles on the shape of the nightside of the magnetosphere is examined. Corresponding methods for computation are described and results of the numerical calculations given. These are compared with measurements made by the satellite IMP-1. (auth) (STAR)

1044 (MPI-PAE-EXTRATERR.-19/65) EXTRATERRESTRISCHE ELEKTRONENDICHTE-MESSUNGEN. TEIL I: WAHL DER MESSMETHODE. (Extraterrestrial Electron Density Measurements. Part I. Choice of Method of Measurement). Rabben, H. H. (Max-Planck-Institut fuer Physik und Astrophysik, Munich (West Germany)). Dec. 1965. 8p. (In German). Dep. CFSTI.

Application of known methods of measurement (wave propagation and plasma probes) is discussed and a new method for measurements in the magnetosphere and interplanetary medium is proposed which is based on the interaction of plasma and electromagnetic waves. (STAR)

1045 (MPI-PAE-EXTRATERR.-31/66) DIFFERENTIELLES DOPPLERVERFAHREN FUER MAGNETOSPHAERISCHE UND INTERPLANETARE ELEKTRONENDICHTE-MESSUNGEN. (Differential Doppler System for Magnetospheric and Interplanetary Electron Density Measurements). Rabben, H. H. (Max-Planck-Institut fuer Physik und Astrophysik, Munich (West Germany)). June 1966. 33p. (In German). Dep. CFSTI.

Following the successful ionospheric electron density measurements by Seddon (1953) using the differential Doppler system the suitability of this relatively simple technical process is discussed for both the magnetosphere and the interplanetary medium. This process is compared with the proposed wave propagation method for direct determination of the plasma frequency. The choice of method depends on the marginal conditions of the measurements. (auth) (STAR)

1046 (N-67-18704) TOPOLOGICAL STUDY OF THE MOTION OF PARTICLES TRAPPED IN A MAGNETIC FIELD. Ray, Ernest C. (National Aeronautics and Space Administration, Greenbelt, Md. Goddard Space Flight Center). [1963]. 15p. (NASA-TM-X-57232). CFSTI.

The possible existence of magnetic fields is explored for the curves representing the adiabatic integral invariant (J) that are constant and a family of spirals. A necessary condition for this is that J = exists as a constant spiral surface so that a particle spiraling around it does not usually drift off the surface, since J would suffer a discontinuity as a particle crossed it. It is then shown that no family of curves for J = constant can be a family of spirals, for which through each point in the alpha, the beta space passes exactly one member of the family. Since one member of the family passes through each point, no member intersects either itself or any other member. It is considered unlikely that any reasonable model of the Earth's magnetic field possesses any of the properties that permit the set of curves J = constant to be a spiral, or that any such fields can be constructed; and before a model can be attempted, the existence of the magnetic field that produces a spiral family of curves J = constant must be proven. (STAR)

1047 TABLES OF VIRTUAL HEIGHTS FOR MODELS OF MONOTONIC AND NONMONOTONIC IONOSPHERIC LAYERS. Herbert, Th. (Max-Planck-Institut fuer Aeronomie, Lindau, Ger.). Radio Sci., 2: 1269-77(Oct. 1967).

A group of mathematical ionospheric models are defined and given numerically together with precisely calculated virtual heights. The models are intended to permit decisive tests and intercomparison of N(h) methods. (auth)

1048 QUICK MODEL METHOD FOR OBTAINING REAL-HEIGHT PARAMETERS FROM ROUTINE IONOSPHERIC DATA. Taieb, C. (Groupe de Recherches Ionospheriques, Paris). Radio Sci., 2: 1263-7(Oct. 1967).

A method is presented by which profile parameters of the F region may be obtained from the ionogram measurements systematically collected and published by the world ionosonde network. The graphical procedures allow for the effect of the Earth's magnetic field, and correct for underlying layers. (auth)

1049 COMPUTATION AND APPLICATION OF SYNOPTIC IONOSPHERIC PROFILES. Laird, A. R.; Wright, J. W. (Inst. for Telecommunication Sciences and Aeronomy, Boulder, Colo.). Radio Sci., 2: 1255-61(Oct. 1967).

Results from the Institute for Telecommunication Sciences and Aeronomy (ITSA) synoptic surveys of ionospheric morphology by systematic calculation of large numbers of electron-density profiles are described. Averages of individual hourly profiles provide a quantitative measure of the day-to-day variability of the ionosphere in addition to much information concerning average ionospheric structure. The average profiles can also be obtained from a "composite virtual-height curve" representing all of the observations at a given hour in a month. It is shown that these two ways of obtaining averages are equivalently useful for survey purposes. Observations from five years of profile calculations using both systems illustrate the decrease of F-region electron content, height of peak density, and characteristic thickness with decreasing solar flux in a 12-month running average. (auth)

1050 DIRECT MANUAL CALCULATIONS OF IONOSPHERIC PARAMETERS USING A SINGLE-POLYNOMIAL ANALYSIS. **Titheridge, J. E. (Univ. of Auckland, New Zealand). Radio Sci., 2: 1237-53(Oct. 1967).**

Two extensions of the basic polynomial analysis are described. Firstly the polynomial representation of the real-height curve is modified to include a parabolic peak: this greatly increases the accuracy of calculations near the peak of the ionospheric layers. Secondly the analytic expression for the real-height curve is used to obtain expressions for the height of the peak (h_m) and the scale height at the peak (H). Integration of the real-height curve also gives an expression for the effective subpeak thickness of the ionosphere (T), defined as the total amount of ionization below the peak divided by the density at the peak. These three expressions are then used to obtain coefficients relating h_m, H, and T to the virtual heights at any required frequencies. Eighty-four sets of coefficients are given for analyzing h'(f) records taken anywhere in the world, with critical frequencies between 1.5 and 20 MHz. These coefficients give the values of h_m, H, T, and the real heights of reflection directly in terms of the virtual heights at five or six different frequencies. For calculations on a single ionospheric layer the accuracy is extremely high, being equivalent to that obtained with a lamination analysis using more than 50 points. For calculations on the daytime F region, coefficients are provided with alternative sampling points chosen to reduce the effects of the E and F1 layer cusps, so that the height, scale height, and total content of the F region can be determined with an accuracy equivalent to a lamination analysis using more than 20 points. Finally, coefficients including an extraordinary-ray correction for the underlying ionization are given, to enable accurate calculations for the nighttime F region. (auth)

1051 TEN-POINT METHOD OF IONOGRAM REDUCTION. **Schmerling, E. R. (Pennsylvania State Univ., University Park). Radio Sci., 2: 1233-6(Oct. 1967).**

The "ten-point" manual method of ionogram reduction provides true heights at selected frequencies. The method is especially convenient when only the height of maximum density is required, but it can also be used to obtain the complete profile. A single true height is obtained as the average of ten virtual heights sampled at fixed submultiples of the frequency. The sampling points, which depend on the geomagnetic parameters, may be rapidly selected by using the appropriate transparent overlay. A correction for underlying ionization may be incorporated by reading one virtual height from the extraordinary trace. (auth)

1052 ON THE MANUAL AND DIGITAL COMPUTER METHODS USED AT LINDAU FOR THE CONVERSION OF MULTIFREQUENCY IONOGRAMS TO ELECTRON DENSITY-HEIGHT PROFILES. **Becker, W. (Max-Planck-Institut fuer Aeronomie, Lindau, Ger.). Radio Sci., 2: 1205-32(Oct. 1967).**

Real-height analysis of multifrequency ordinary and extraordinary virtual-height traces has been carried out at Lindau since 1956. The methods take account of underlying ionization and extrapolate the real-height profile up to the peak of the layer under discussion. This extrapolation is based on observed virtual heights rather than on deduced real heights. At least second-order approximations of the profile are used here. All of the methods allow for analysis of monotonic and nonmonotonic virtual-height traces. They differ only in their final accuracy. A model method is described first; only 8 min are necessary to reduce a simple F trace. The respective real-height data have proved very useful for statistical purposes. Since 1957, very accurate and general manual methods have been in use. One and one-half hours are necessary for a full analysis of one ionogram. While these methods rely on an estimate by eye of the critical frequency of the layer of interest, the digital computer method in general use at Lindau since 1962 deduces this value too. The accuracy of this digital computer method is much better than the technical accuracy of the present ionosondes. A complete real-height analysis of one virtual-height trace, showing a critical frequency of 16 MHz, amounts to about 14 min of computer time (IBM 650). Test results on a series of theoretical ionograms of monotonic and more or less complicated nonmonotonic electron density–height profiles, valley profiles, are also reported. (auth)

1053 USE OF VIRTUAL-HEIGHT SLOPES FOR DETERMINATION OF ELECTRON-DENSITY PROFILES. **Paul, Adolf K. (Inst. for Telecommunication Sciences and Aeronomy, Boulder, Colo.). Radio Sci., 2: 1195-1204(Oct. 1967).**

The relationship between the slope of an ionospheric virtual-height curve and the higher derivatives of the N(h) profile is derived and discussed. The slope is found to depend mainly on the second-height derivative at the reflection point of the probing wave. A method of ionogram analysis based upon this formulation is proposed. The appendix presents new forms of the phase refractive index and its derivatives. (auth)

1054 DIRECT USE OF THE PHASE REFRACTIVE INDEX FOR REDUCING h'(f) CURVES TO N(h) PROFILES. **Hojo, H. (Radio Research Labs., Tokyo). Radio Sci., 2: 1177-93(Oct. 1967).**

A method for obtaining N(h) profiles from h'(f) curves by the direct use of the phase refractive indices is developed for both the the ordinary and extraordinary modes. The method is extended for solving the starting problem by the joint use of ordinary and extraordinary h'(f) curves and by assuming the Chebyshev expansion regarding the profile below f_{min}. It is pointed out that the phase height at f_{min} is useful for obtaining an accurate profile above f_{min}. The profile is assumed to be a monotonic function of height, but the method can be extended to include the profile containing a valley. The effect of the Earth's magnetic field is included without a height variation, and the method neglects the effect of electron collisions. (auth)

1055 OVERLAPPING-POLYNOMIAL ANALYSIS OF IONOGRAMS. **Titheridge, J. E. (Univ. of Auckland, New Zealand). Radio Sci., 2: 1169-75(Oct. 1967).**

A simple and more direct derivation of the equations used in the overlapping-polynomial analysis of ionograms is given. A set of five simultaneous equations is obtained which define the five polynomial coefficients required at each frequency. The steps involved in programming a computer to calculate these coefficients and analyze a virtual-height record are outlined. The calculation of the coefficients takes about 40 percent longer than the calculation of the coefficients for a lamination analysis using the same number of points. Since, however, the polynomial method requires only about one quarter as many points as a lamination analysis for a given accuracy, a considerable saving is achieved both in time required for measuring the virtual heights and in the computer time required for calculating the coefficients and analyzing the records. A procedure for allowing for the presence of ionization below the nighttime F region is also described; this includes corrections for both the low-density ionization in the E region and the finite ionization gradient at the bottom of the F region. (auth)

1056 IONOSPHERIC ELECTRON-DENSITY PROFILES WITH CONTINUOUS GRADIENTS AND UNDERLYING IONIZATION CORRECTIONS. III. PRACTICAL PROCEDURES AND SOME INSTRUCTIVE EXAMPLES. **Wright, J. W. (Inst. for Telecommunication Sciences and Aeronomy, Boulder, Colo.). Radio Sci., 2: 1159-68(Oct. 1967).**

A description is given of procedures developed at the Institute of Telecommunication Sciences and Aeronomy (ITSA) to permit accurate extraction of virtual-height data from ionograms in a form easily usable by digital computers. Criteria are described for identification of the significant interval limits along ionogram echo traces. (auth)

1057 IONOSPHERIC ELECTRON-DENSITY PROFILES WITH CONTINUOUS GRADIENTS AND UNDERLYING IONIZATION CORRECTIONS. II. FORMULATION FOR A DIGITAL COMPUTER. **Howe, H. Herbert; McKinnis, Dean E. (Inst. for Telecommunication Sciences and Aeronomy, Boulder, Colo.). Radio Sci., 2: 1135-58(Oct. 1967).**

Details are given of a practical computer formulation of the solution to the ionogram real-height problem developed at the Institute of Telecommunication Sciences and Aeronomy (ITSA) by A. K. Paul. The method can make full joint or independent use of the ordinary and extraordinary group-height information available from modern high-quality radio soundings of the ionosphere. It takes advantage of the strong dependence of group height on the vertical electron-density gradient at the reflection level to provide a profile with continuous gradients; this is an important feature when applying profile data to radio ray tracing or certain aeronomical problems. Corrections for the "starting" and "valley" portions of the distribution (not directly observed on the soundings) are made by fitting simple models for these regions to portions of the ordinary and/or extraordinary echo data. The problem of numerical convergence of integrals involving the group refractive in-

dex infinity is solved by a new expression for the index in which the singular part can be integrated explicitly. The layer maximum is obtained by a parabolic extrapolation which maintains the continuity of gradient to the layer peak and which does not require an independent estimate of the critical frequency. (auth)

1058 IONOSPHERIC ELECTRON-DENSITY PROFILES WITH CONTINUOUS GRADIENTS AND UNDERLYING IONIZATION CORRECTIONS. I. THE MATHEMATICAL-PHYSICAL PROBLEM OF REAL-HEIGHT DETERMINATION FROM IONOGRAMS. Paul, Adolf K. (Inst. for Telecommunication Sciences and Aeronomy, Boulder, Colo.). Radio Sci., 2: 1127-33(Oct. 1967).

Any numerical method for inversion of the integral equation $h'(f) = \int_0^{h^R(f)} \mu'(f_N(z),f)dz$ must satisfy certain requirements in order to avoid introducing features into the true-height profile which are not indicated by the ionogram. These requirements are first investigated by considering the equation as an integral transformation of $f_N(z)$ for several model distributions. In order to satisfy the above-mentioned criteria, a second-order lamination process was developed; its mathematical principles are presented. (auth)

1059 REVIEW OF CURRENT METHODS FOR OBTAINING ELECTRON-DENSITY PROFILES FROM IONOGRAMS. Wright, J. W.; Smith, G. H. (Inst. for Telecommunication Sciences and Aeronomy, Boulder, Colo.). Radio Sci., 2: 1119-25(Oct. 1967).

Certain aspects of the general ionogram analysis problem, common to most methods of attack, are discussed. Present attainable accuracies and criteria affecting the choice of method for typical problems are discussed. Results are included of discussions of the URSI–CIG Subcommittee on N(h) profiles held at its meeting in London, May 1964. (auth)

1060 ESTABLISHMENT OF A LUNAR UNIPOLAR GENERATOR AND ASSOCIATED SHOCK AND WAKE BY THE SOLAR WIND. Sonett, C. P.; Colburn, D. S. (Ames Research Center, Moffett Field, Calif.). Nature (London), 216: 340-3(Oct. 28, 1967).

The impact of the solar wind on a dynamo- and atmosphere-free body such as the Moon generates two distinguishable current systems denoted as Cowling ($\dot{B} \neq 0$) and unipolar ($\dot{B} = 0$). The unipolar system representing the steady state must close through the neighbouring plasma and thus has the form of a simple linear unipolar generator. The relationship of the current to the conductivity is investigated for the homogeneous and the radially inhomogeneous Moon. The current density is determined by the power flow in the solar wind and the conductivity of the body. The fundamental equation for the interior potential associated with the unipolar generator is solved for a special case. (auth) (UK)

1061 A NOTE ON AURORAL-TYPE FLUCTUATIONS IN THE EARTH'S ELECTROMAGNETIC FIELD. Paulson, K. V.; Shepherd, G. G.; Graystone, P. (Univ. of Saskatchewan, Saskatoon). Can. J. Phys., 45: 2813-21(Aug. 1967).

Simultaneous recordings are shown and analyzed in order to compare geomagnetic and telluric-current fluctuations and telluric-current and auroral-brightness fluctuations. Data are also included on simultaneous two-station measurements of telluric currents. (J.H.M.)

1062 RESULTS OF POLAR IONOSPHERE INVESTIGATION BY MEANS OF EXPLORER-22 RADIO SIGNALS. Mityakova, E. E.; Mityakov, N. A.; Cherepovitskii, V. A. (Gorky State Univ., USSR). Izv. Vyssh. Ucheb. Zaved., Radiofiz., 10: 1070-6(1967). (In Russian).

The measurement data on an integral electron density in the ionosphere N_{ic} are given by means of recording the phase difference of coherent frequencies 20.005 and 40.010 Mc from Explorer-22 in Loparskoy. The observations were carried out during August 28 to December 24, 1965. Diurnal and seasonal variations of different parameters of the polar ionosphere were considered, as well as the dependence of these parameters on the solar and magnetic activity. (auth)

1063 ELECTRON CONTENT OF THE ANTARCTIC IONOSPHERE, 1966. Stephens, Craig P.; Mott, David L. (New Mexico State Univ., University Park). Antarctic J. U. S., 2: 169-70(Sept.-Oct. 1967).

Measurements of the total electron content of the Antarctic ionosphere were made by reference to data obtained by measuring the Doppler shift of radio-frequency signals from Earth satellites. The data were recorded at the Doppler satellite tracking station at McMurdo. Results of the measurements are plotted. The data indicate that the electron content of the Antarctic ionosphere decreases during periods of high geomagnetic activity. (J.H.M.)

1064 ROCKET MEASUREMENTS IN PROTON AURORA. Whalen, B. A.; McDiarmid, I. B.; Budzinski, E. (National Research Council of Canada, Ottawa). Can. J. Phys., 45: 3247-56(Oct. 1967).

Proton and electron intensities, energy spectra, and angular distributions derived from a recent rocket flight launched into a 40-rayleigh H_β aurora are reported. High-intensity proton precipitation (~0.45 erg cm^{-2} s^{-1} for protons with energies above 30 keV) was detected throughout the flight above 100 km, whereas the electron intensity was above the limit of detectability for only a short time. The proton and electron spectra and angular distributions in the 20 to 60 keV energy range were found to be remarkably similar, with angular distributions being isotropic over the pitch-angle range 0 to 90°, and with e-folding energies of about 12 keV and 18 keV for protons and electrons respectively. The results are interpreted in terms of current magnetospheric models, and are shown to place certain restrictions on the source mechanisms. (auth) (Canada)

1065 INFRASONIC PRESSURE WAVES FROM THE AURORA: A SHOCK WAVE MODEL. Wilson, Charles R. (Univ. of Alaska, College). Nature (London), 216: 131-3(Oct. 14, 1967).

The anisotropic radiation of infrasonic waves from moving aurorae is explained by a shock wave model. The acoustic waves, as observed on the ground at a site ahead of the moving aurora, are amplified in the direction parallel to the auroral motion by superposition of wave fronts if the auroral form is moving at supersonic speed. (auth) (UK)

1066 GEOMAGNETIC, AURORAL, IONOSPHERIC, AND COSMIC-RAY PERTURBATIONS: INTERDEPENDENCE AND RELATIONSHIP WITH SOLAR ACTIVITY. Mariani, F. (Univ., Rome); Molina, F. Ann. Geofis. (Rome), 19: 287-334(1966). (In Italian).

A discussion is presented of the existence of interplanetary magnetic fields other than the geomagnetic field. These fields travel as frozen-in fields inside the solar plasma clouds: magnetic fields on the sun are discussed. Radioemission phenomena are considered from the viewpoint of their association and correlation with the interplanetary magnetic field and solar-plasma phenomena. The morphology and geographical distribution of PCA events and their correlations with solar phenomena are reviewed, and experimental results on solar protons events are discussed. (IAA)

1067 AN IN SITU PROBE SYSTEM FOR THE MEASUREMENT OF IONOSPHERIC PARAMETERS. Bettinger, Richard Thomas. College Park, Md., Univ. of Maryland, 1964. 485p. Thesis.

The ionosphere has been the subject of experimental investigation for many years. The advent of the rocket sounding vehicle and, more recently, the satellite has considerably intensified this activity. The earlier work utilized various propagation techniques involving the interaction of the ionospheric electrons and electromagnetic radiation. Much of the current experimental emphasis has shifted to in situ probes which are, potentially, capable of more refined measurements of vairous ionospheric parameters. These include: (1) nonthermal components of the electron energy distribution; (2) small scale ionization inhomogeneities; (3) negative ion concentrations in the lower ionospheric regions; and (4) time and spatial variations in the foregoing parameters. This increased versatility is achieved at the expense of experimental complexity in both equipment and data interpretation. The most difficult problem encountered is the electric potential acquired by the carrier vehicle and its variations and perturbations. A complete in situ probe system consisting of (1) thermal equalization probes capable of independently measuring vehicle potential, (2) a pulse probe to measure electron concentration and energy distribution, and (3) a Langmuir probe which will supply information on positive ion and electron temperatures has been designed and tested. This system, along with the requisite telemetry elements were then packaged into an ejectable rocket payload. Preliminary flight test results are presented indicating generally satisfactory operation of the various probes and pointing to a number of design modifications. Vehicle potentials have been measured on several flights. Its reaction to dc sweeps, vehicle velocity and solar radiation is demonstrated and discussed. It is concluded that a high-energy tail in the normal daytime electron energy distribution exists. (Disser. Abstr.)

Low-Temperature Physics

Refer also to abstracts 1325, 1346, and 1364.

1068 (AD-646909) ON THE BULK (H_{c2}) AND SURFACE (H_{c3}) NUCLEATION FIELDS OF STRONG COUPLING SUPERCONDUCTING ALLOYS. Eilenberger, Gert H. U.; Ambegaokar,

Vinay (Cornell Univ., Ithaca, N. Y. Lab. of Atomic and Solid State Physics). Jan. 1967. Contract Nonr-401(38). 33p. (TR-17). CFSTI.

The linearized self consistency equation, in the electron phonon model, for the nucleation of superconductivity in the presence of a magnetic field was studied. It was found that near the transition temperature this integrodifferential equation is susceptible to analysis. The main results were that the ratio of surface to bulk nucleation fields was predicted to have the weak coupling value of 1.695, thus not confirming a recent experimental suggestion of a value near 1.9 for strong coupling superconductors. The slope $(dH_{c3}/dT)_{T_c}$ was worked out both in terms of integrals over the parameters of the bulk strong-coupling theory and in terms of other experimental quantities. Comparison of this last result with existing experiments on pure lead was attempted, with good success. An implicit equation for H_{c3} (T) for all T was derived, but the numerical work necessary to solve this equation was not undertaken. (auth)

1069 (ISS-67/15) GAUGE INVARIANCE PROPERTIES OF AN INTERACTING BOSE SYSTEM. de Pasquale, F.; Tabet, E. (Istituto Superiore di Sanita, Rome (Italy). Laboratori di Fisica). June 17, 1967. 14p. Dep.

Previous results on gauge invariance properties for a Bose system are extended to the finite temperature case. A discussion of sum rules for a superfluid Bose system is also given. (auth)

1070 NEUTRON IRRADIATION EFFECTS IN SUPERCONDUCTING NIOBIUM. Kernohan, R. H.; Sekula, S. T. (Oak Ridge National Lab., Tenn.). J. Appl. Phys., 38: 4904-10(Nov. 1967). (ORNL-P-3181).

The superconducting magnetization behavior and transition temperatures of single crystals of Nb were investigated prior to and after a series of fast-neutron irradiations (E > 1 MeV) in the Oak Ridge Research Reactor at a temperature of approximately 40°C. The experimental results indicate that the point defects and defect aggregates which are created lead to increases in the upper critical field H_{c2} and small changes in the superconducting transition temperature. In addition, the increase in nonequilibrium behavior of the magnetization with integrated fast-neutron flux establishes that defects are present with the ability to pin magnetic flux. For fast-neutron doses of approximately 2×10^{19} neutrons/cm^2, the magnetization approaches in behavior that of a completely irreversible type-II superconductor. Successive reductions in cross-sectional area of this sample by chemical etching and subsequent measurements of the magnetization indicate only a small size dependence of the hysteresis, indicating essentially complete flux pinning in a macroscopic sheath approximately 0.1 mm thick. The flux-pinning defects are considered to be dislocation loops as evidenced by other work, and the present experimental results are discussed in terms of these loops. (auth)

1071 HEAT EXCHANGE TORQUES IN SUPERFLUIDS. Penney, R. (Ford Motor Co., Dearborn, Mich.). Phys. Fluids, 10: 2147-8(Oct. 1967).

It is shown that the two-fluid model of helium II leads to the existence of heat exchange torques on nonuniformly heated bodies immersed in flowing helium. The torques on a long cylinder is calculated and shown to be of a magnitude which should be readily observable. (auth)

1072 ON THE SURFACE TENSION OF LIQUID HELIUM II. Brouwer, W.; Pathria, R. K. (Univ. of Alberta, Edmonton). Phys. Rev., 163: 200-5(Nov. 5, 1967).

The "intrinsic" surface tension of liquid He II, arising from the structural energy of the free surface, is calculated on the basis of Gross and Pitaevski's imperfect-gas model. The resulting expression, when supplemented by the contribution arising from the presence of quantized surface modes of vibration, gives a value of 0.28 erg cm^{-2} for the surface tension of liquid helium in the limit T → 0°K. This value compares well with the experimental estimate of 0.37 erg cm^{-2}. It is also demonstrated that the so-called boundary effects, which arise from a better enumeration of the density of states in a bounded statistical system, do not make a significant contribution to the temperature dependence of the surface tension. The dominant contribution is again the one due to the quantized surface modes. (auth)

1073 ZERO SOUND IN ^{3}He IN A MAGNETIC FIELD. Schappert, G. T. (Brandeis Univ., Waltham, Mass.). Contract AF 19(628)-5833. Phys. Rev., 163: 195-200(Nov. 5, 1967).

The velocity of zero sound in low-temperature liquid ^{3}He is slightly changed in the presence of an external magnetic field. This shift is due to the change of the Fermi surface of the quasi particles and a coupling of zero-sound waves to longitudinal spin waves. The total shift $\delta S/S_0$ is shown to be proportional to $(\gamma H/p_F v_F)^2$. The coefficient of proportionality was estimated to be about 4. (auth)

1074 HEAT CAPACITY AND FREEZING CURVES OF FLUID ^{3}He AND ^{3}He–^{4}He MIXTURES. Pandorf, R. C.; Ifft, E. M.; Edwards, D. O. (Ohio State Univ., Columbus). Phys. Rev., 163: 175-7(Nov. 5, 1967).

The heat capacity at constant volume, C_v, and the freezing curves, p–T and p–V, have been measured for ^{3}He–^{4}He fluid mixtures of ^{3}He concentration, X = 0.17, 0.51, 0.79, and 0.95, between 50 and 150 atm and up to 4.5°K. Some measurements of C_v for pure ^{3}He and ^{4}He were also made in the same range. It is found that the freezing pressure is linear in X, $p(X,T) = Xp_3^0(T) + (1 - X)p_4^0(T)$, within 1 atm; and that the excess volume at freezing, V^E, is smaller than ±0.04 cm^3/mole. The specific heat C_v can be fitted by a linear interpolation between C_v at the same volume and temperature for the pure isotopes. Calculations of the discontinuous change in C_v on freezing, based on these linear interpolations, are in fair agreement with experimental values. (auth)

1075 HEAT CAPACITY OF A MIXED-TITANATE SUPERCONDUCTOR. Colwell, J. H. (National Bureau of Standards, Washington, D. C.). Phys. Lett., 25A: 623-4(Oct. 23, 1967).

The heat capacity of semiconducting $Sr_{0.925}Ba_{0.075}TiO_3$ has been measured between 0.3 and 4°K. The superconducting transition is observed at 0.5°K. An anomaly in the normal-state heat capacity is interpreted as a change in the number of valleys in the conduction band. (auth)

1076 PRESSURE-INDUCED ENERGY SHIFTS IN THE PHONON SPECTRUM OF Pb OBSERVED BY ELECTRON-TUNNELING. Franck, J. P.; Keeler, W. J. (Univ. of Alberta, Edmonton). Phys. Lett., 25A: 624-5(Oct. 23, 1967).

The technique of electron tunneling into superconductors has been used to study the energy shifts in the phonon spectrum of Pb induced by approximately hydrostatic pressures up to 3445 bar. The shift of the transverse and longitudinal phonon peak with pressure was clearly resolved. The relation between superconducting transition temperature of Pb and pressure was found to be $dT_c/dP = -(3.5 \pm 0.1) \times 10^{-6}$ deg/bar. (auth)

1077 NERNST EFFECT IN SUPERCONDUCTING FILMS OF TIN AND INDIUM. Huebener, R. P. (Argonne National Lab., Ill.). Phys. Lett., 25A: 588-9(Oct. 23, 1967).

Transverse voltages due to longitudinal temperature gradients have been observed in superconducting films of tin and indium. The entropy per flux quantum associated with a vortex of unit length is found to be an order of magnitude larger than the value calculated for a very large flux bundle, where the surface energy contribution can be neglected. (auth)

1078 SUPERCONDUCTIVITY OF NIOBIUM THIN FILMS DEPOSITED BY dc-DIODE SPUTTERING. Sosniak, J.; Hull, G. W. Jr. (Bell Telephone Labs, Inc., Murray Hill, N. J.). J. Appl. Phys., 38: 4390-2(Oct. 1967).

Niobium films with superconducting transition temperatures between 8.2 and 9.1°K have been deposited by dc diode sputtering. The results are shown to be due to the reduction of the film impurity content by extensive presputtering and high substrate temperatures. (auth)

1079 SUPERCONDUCTIVITY IN THE TECHNETIUM–VANADIUM ALLOY SYSTEM. Koch, C. C.; Kernohan, R. H.; Sekula, S. T. (Oak Ridge National Lab., Tenn.). Contract W-7405-eng-26. J. Appl. Phys., 38: 4359-64(Oct. 1967). (ORNL-P-3059).

The superconducting properties of Tc–V alloys with compositions ranging from 0 to 100 at. % V have been investigated in fields up to 15 kOe by measurements of the bulk magnetization determined ballistically. A phase diagram of the Tc–V system has been determined by several metallurgical techniques. The sequence of crystal structures at 1500°C with increasing vanadium content is hcp → bcc → CsCl → bcc. The technetium-rich bcc phase when quickly cooled to room temperature exhibits superlattice x-ray diffraction lines of the CsCl structure. The superconducting transition temperature of the technetium-rich hcp alloys increases with vanadium concentration from 7.73°K to a maximum for the system of 11.3°K at the limit of vanadium solubility (~6.5 at. % V). This transition temperature remains constant for the two-phase alloys. The transition temperature decreases progressively with increasing vanadium content in the CsCl structure, and at compositions in the 50 to 80 at. % V interval no evidence of superconductivity is observed for temperatures at low as 1.4°K. Alloys containing the hcp phase show reversible behavior in the tails of their magnetization curves, while those with the CsCl structure exhibit a high degree of hysteresis in the tails. Estimates of the upper-critical field at 0°K, $H_{c_2}(0)$, using the experimental data and theoretical calculations yield values of $H_{c_2}(0)$ to approximately 45 kOe for the samples with high-transition temperatures. Results of heat treatment at 1100°C on the superconducting parameters of alloys near the 30 at. % V composition are presented. (auth)

1080 UPPER CRITICAL FIELD OF A SUPERCONDUCTOR BACKED BY A NORMAL METAL. Deutscher, G. (CNRS, Orsay, France. Faculte des Sciences, Orsay, France); Hurault, J. P.; Meunier, F.; Saint-James, D. Phys. Lett., 25A: 514-15(Oct. 9, 1967).

The nucleation field H at the free surface of a superconductor S backed by a normal metal N for different values of the extrapolation length b of the pair potential into N was studied. A satisfactory agreement was found between theory and experiment. (auth)

1081 ENHANCED POLARIZATION IN ^{3}He–^{4}He SOLUTIONS. Campbell, L. J. (Univ. of Illinois, Urbana). Phys. Lett., 25A: 524-5(Oct. 9, 1967).

It is pointed out that the equilibrium ratio of the nuclear spin polarizations of two ^{3}He systems in contact is proportional to the ratio of their volume susceptibilities and inversely proportional to the ratio of their densities. Hence the polarization of dilute ^{3}He–^{4}He solutions can be enhanced by 40% or more over the polarization of pure ^{3}He. (auth)

1082 PROXIMITY EFFECTS IN EUTECTIC ALLOYS TRANSITION TEMPERATURE AND SPECIFIC HEAT. Yeh, R. H. T.; Mechetti, H. (Univ. of Virginia, Charlottesville). Phys. Lett., 25A: 531-2(Oct. 9, 1967).

The Ginzburg–Landau equation and Zaitsev's boundary conditions are used to compute the superconductive transition temperature and the specific heat jump of eutectic alloys. Good agreement with experiments is obtained. (auth)

1083 NOTE ON COLLECTIVE VORTEX VIBRATIONS IN TYPE-II SUPERCONDUCTORS. Stauffer, D. (Max-Planck-Institut fuer Physik and Astrophysik, Munich). Phys. Lett., 25A: 540(Oct. 9, 1967).

The hydrodynamical model is used to calculate the damping of two-dimensional vibrations in a triangular vortex lattice. (auth)

1084 IDEAL RESISTIVE TRANISTION OF A SUPERCONDUCTOR. Glover, R. E. (Univ. of Maryland, College Park). Phys. Lett., 25A: 542-4(Oct. 9, 1967).

Precise measurements of the change of conductivity with temperature have been made for stabilized amorphous bismuth films. The experiments indicate that the initial rapid change of conductivity at the superconducting transition depends on temperature as $(T-T_c)^{-\frac{1}{2}}$. This extends over a temperature range of about 3 millidegrees. At higher temperatures the dependence is found to be $(T-T_c)^{-1}$. (auth)

1085 PREDICTED CRITICAL BEHAVIOR NEAR THE SUPERCONDUCTING PHASE TRANSITION. Ferrell, R. A.; Schmidt, H. (Univ. of Virginia, Charlottesville). Phys. Lett., 25A: 544-5(Oct. 9, 1967).

The critical temperature region is much larger in an alloy than in a pure superconductor. It may become of the order of 0.1% of T_c. Here the penetration depth squared, the diamagnetic susceptibility, and the dc conductivity are predicted to vary as $|T-T_c|^{-\frac{1}{2}}$. (auth)

1086 ON AN OBJECTION TO THE PATASHINSKII–POKROVSKII THEORY OF THE λ TRANSITION IN LIQUID ^{4}He. Moore, M. A. (Oxford Univ.). Phys. Lett., 25 A: 499-500(Oct. 9, 1967).

It is shown that the often-made criticism of the Patashinskii–Pokrovskii theory that it fails when applied to the Ising model implies no criticism of its validity for the λ transition. (auth)

1087 EDGE EFFECTS IN THE TUNNELING CHARACTERISTICS OF SUPERCONDUCTING DIODES. Thorsen, A. C.; Wolfram, T.; Valby, L. E. (North American Aviation Science Center, Thousand Oakes, Calif.). Phys. Lett., 25A: 548-9(Oct. 9, 1967).

The tunneling characteristics of thin-film aluminum diodes in the superconducting state show anomalies at voltages above the bulk energy gap, which can be associated with the tunneling of quasi particles through the film edges. The anomalies are interpreted in terms of a series of discrete gaps associated with the edges. (auth)

1088 ANALYSIS OF BACKGROUND NOISE IN TYPE-II SUPERCONDUCTORS. Fournet, G.; Baixeras, J. (Faculte des Sciences, Paris. LCIE, Fonteney-aux-Roses, France). Phys. Lett., 25A: 552-3(Oct. 9, 1967). (In French).

Noise measurements have been carried out by other authors, and in a proposed explanation of their results a previous statistical model for the velocities of the vortices is used. In this way a proper velocity is assigned to each vortex instead of considering a single one for all the vortices. The resulting noise spectrum is calculated and is found equal to the sum of elementary spectra produced by each velocity. Therefore this spectrum does not reach zero value, and this fact seems to be in fairly good agreement with the experimental data. (auth)

1089 INFLUENCE OF OSCILLATING FIELDS ON THE HALL EFFECT AND RESISTANCE OF SUPERCONDUCTING NIOBIUM. Fiory, A. T.; Serin, B. (Rutgers-The State Univ., New Brunswick, N. J.). Phys. Lett., 25A: 557-8(Oct. 9, 1967).

Direct-current Hall and resistive voltages in the flux-flow state were measured in the presence of an oscillating magnetic field perpendicular to the static field. The induced alternating current depinned the vortices. The Hall angle in the flux-flow state obtained in this way shows the same dependence on magnetic field as in the normal state. (auth)

1090 MEASUREMENT OF LOW JOINT RESISTANCE BETWEEN SUPERCONDUCTORS. Atherton, David (Ferranti-Packard Electric Ltd., Toronto). Can. J. Phys., 45: 2809-10 (Aug. 1967).

A method of measuring the joint resistance is described in which a length of superconductor is joined into a closed loop, first determining or calculating its inductance, and then observing the decay of an induced current by field measurement; the observed time constant enables the total loop resistance to be inferred. A multistrand copper-clad Nb–Zr stabilized superconductor was used in conjunction with homopolar rotary flux pump. Multicore copper-clad Nb–Ti was tested by soldering together the ends of a 4-μH coil placed round a permanent magnet. The techniques presented conveniently demonstrate that the very low resistance joints needed for heavy current-stabilized superconductors are easily obtainable by soldering. (M.H.R.)

1091 GROUND STATE OF A SUPERCONDUCTOR WITH A SINGLE MAGNETIC IMPURITY. Hone, D. (Univ. of Pennsylvania, Pa.). Solid State Commun., 5: 705-8(Sept. 1967).

The variational ansatz used by Heeger and Jensen to study the ground state for the Kondo problem in normal metals is extended to describe a superconductor containing a single paramagnetic impurity. Using as a model the s-d Hamiltonian with antiferromagnetic exchange coupling J, a singlet bound state for $\log T_K/T_c \geq -\pi/2$ is found, where T_K is the Kondo temperature associated with J, and T_c is the superconducting transition temperature of the host. Direct connection is made with the results obtained for these systems by Maki, who used the methods of Chew–Low scattering theory. (auth)

1092 INFLUENCE OF PLASTIC DEFORMATION ON CRITICAL CURRENT DENSITY OF CERTAIN SUPERCONDUCTING ALLOYS. Pakhomov, V. Ya.; Lainer, D. I. Fiz. Metal. Metalloved., 23: 939-41(May 1967). (In Russian).

The effect of cold deformation of Nb + 46% Ti and Alloy-2 wire specimens, 0.25-mm diameter, on the critical current density was determined. The alloy specimens were prepared after the method of Pakhomov et al. (Fiz. Metal. Metalloved., 22: 640(1966)); the critical current density was determined in a transverse magnetic field at 4.2°K. The experimental results are shown graphically. It was found that the critical current density in the two alloys investigated depends only weakly on the degree of deformation. The dependence of the magnitude of the critical current density on the alloy composition is explained in terms proposed by Anderson (Phys. Rev. Letters, 9: 309(1962)). (ATD)

1093 ELECTROMAGNETIC PROPERTIES OF SUPERCONDUCTORS WITH OVERLAPPING ZONES. Geilikman, B. T.; Zaitsev, R. O.; Kresin, V. Z. (Moscow Pedagogical Correspondence Inst.). Fiz. Metal. Metalloved., 23: 796-802 (May 1967). (In Russian).

The following properties of superconductors exhibiting overlapping zones were investigated: a) the depth of field penetration and the temperature dependence of the field penetration; b) the effect of strong magnetic fields on the Ginzburg–Landau constant χ (Ginzburg and Landau (Zh. Eksp. Teoret. Fiz., 20: 1064(1958)) and the magnitude of the Josephson's current. It was found that the presence of overlapping zones in the superconductor causes a significant change in the temperature dependence of the depth of penetration from that predicted by the BKSh theory. (TSS) (ATD)

1094 TEMPERATURE DEPENDENCE OF JOSEPHSON'S CURRENT IN ANISOTROPIC SUPERCONDUCTORS. Gorbonosov, A. E.; Kulik, I. O. (Physical-Technical Inst. of Low Temperatures, Kharkov). Fiz. Metal. Metalloved., 23: 803-12(May 1967). (In Russian).

The temperature dependence of the Josephson current in anisotropic superconductors was investigated. Expressions for the Josephson current I_j at T = 0K, T = T_k (T_k is critical temperature equal to the superconducting transition temperature of the conductor), and for arbitrary temperatures in case of small anisotropies are derived. It is shown that experimental data on the temperature dependence of the Josephson current at temperatures approaching absolute zero may be used to determine the absolute minimum in the energy gap of superconductors. (TSS) (ATD)

1095 THE NATURE OF THE RELATIONSHIP BETWEEN THE SUPERCONDUCTIVITY CHARACTERISTICS AND THE MICROHARDNESS OF NIOBIUM. Chizhov, A. Kh. Fiz. Metal. Metalloved., 23: 862-5(May 1967). (In Russian).

A series of niobium specimens (0.07 to 0.1 mm in diameter), with reduction of 0 to 99.985% were tested for their microhardness and electrical properties. It was found that the microhardness and superconductivity characteristics depend on the degree of reduction. Since the reduction changes the structure of the metal, therefore the structure seems to be the basic factor determining these properties. Each of the graphs representing the dependencies of niobium properties on the degree of reduction can be divided into three regions. Thus, in the first region of reduction, an intensive growth of microhardness, critical magnetic field and critical current can be seen. This growth significantly decreases in the second region. In the third region of reduction, the critical current increases only slightly, but the critical magnetic field and the microhardness increase rapidly. (ATD)

1096 THE STRUCTURE OF Zr–4 PERCENT Nb ALLOY AND ITS EFFECT ON THE CRITICAL PARAMETERS OF SUPERCONDUCTIVITY. Sudareva, S. V.; Buinov, N. N.; Romanov, E. P. Fiz. Metal. Metalloved., 23: 871-80(May 1967). (In Russian).

Zr–4% Nb alloy was melted from 99.8%-pure zirconium and 99.4%-pure niobium. Obtained ingots were rolled into bars at 500°C which were subjected to homogenizing annealing in sealed ampules at 1280°C for 50 hr. Specimens obtained from the bars were annealed at 1000°C and oil quenched. The structure and superconducting properties of the alloy were studied on thin metallic films after various degrees of deformation and heat treatments. It was found that the critical temperature and critical current density of Zr–4% Nb alloy depended on the structure, which in turn depended on the heat treatment and tempering time. (ATD)

1097 A CRYOSTAT FOR MEASURING HEAT CAPACITIES FROM 1.2 TO 300°K AND MEASUREMENTS OF THE SPECIFIC HEAT OF MAGNESIUM OXIDE BELOW 36°K. Gmelin, E. (Centre National de Recherches sur les Tres Basses Temperatures, Grenoble, France). Cryogenics, 7: 225-32(Aug. 1967).

Details are given of the construction of a calorimeter to operate in the range from 1.2°K to room temperature, using a gas thermometer for temperature calibration and a mechanical heat switch for specimen cooling. The specific heat of high-purity magnesium oxide has been measured over the temperature range from 1.2 to 36°K and the low-temperature limiting Debye θ was found to be 945 ± 1.5°K. The results can be expressed by the sum of contributions proportional to T^3, T^5, T^7, with the coefficients $A_2 = 4.62 \times 10^{-3}$ μJ/°K⁴ mole, $A^3 = 2.77 \times 10^{-7}$ μJ/°K⁶ mole, and $A_4 = 1.73 \times 10^{-10}$ μJ/°K⁸ mole, respectively. The data agree with those of other workers in the range from 20 to 36°K within the experimental error and with Debye temperatures calculated from low-temperature elastic constant measurements. The variation of the Debye θ as function of temperature is also discussed. (auth)

1098 EXPERIMENT REGARDING THE WAVE FUNCTION OF SUPERFLUID HELIUM. Chester, M.; Guyon, E.; Jones, B. K. (Univ. of California, Los Angeles). Solid State Commun., 5: 807-8(Oct. 1967).

Using as a thermal detector a granular carbon film with an area of about 25 μ side a possible diffraction pattern caused by liquid helium II flowing through a wire grating was looked for. At a detection distance of about 1/4 in. from the grating no effect to within about 10 microdegrees was observed. (auth)

1099 QUARTERNARY SOLID-SOLUTION SUPERCONDUCTORS. Courtney, T. H.; Wulff, J. (Massachusetts Inst. of Tech., Cambridge). Phys. Lett., 25A: 477-8(Sept. 25, 1967).

Small amounts of Y, Gd, and Th, when added to high-oxygen Nb–Ti alloys, have been found to increase the workability of such alloys as well as their critical superconducting current density appreciably. (auth)

1100 MINIMUM PROPAGATING CURRENT OF A SUPERCONDUCTING WIRE IN LIQUID HELIUM. Hancox, R. (Culham Lab., Abingdon, Eng.). Cryogenics, 7: 242(Aug. 1967).

The minimum propagating current of a composite conductor has been measured in the temperature range 5 to 1.8°K. Measurements were made on an uninsulated, copper-clad Nb–60% Ti wire in magnetic fields up to 40 kOe. Results obtained in a magnetic field of 30 kOe are shown together with measured values of the critical current of the conductor. (M.H.R.)

1101 EFFECTS OF LOW-TEMPERATURE AGING ON THE RESISTIVE TRANSITION OF SUPERCONDUCTING 70Zr–30Nb (Cb) IN PULSED MAGNETIC FIELDS. Suenaga, M. (Univ. of California, Berkeley); O'Brien, J. L.; Zackay, V. F.; Ralls, K. M. Trans. Met. Soc. AIME, 239: 992-8(July 1967).

The effects of aging at 400°C on the resistive transition at 4.2°K of a superconducting 70 Zr–30 Nb alloy are reported. Microstructural changes were studied by critical temperature, resistive critical field, residual resistivity, and microhardness measurements and by x-ray diffraction, optical microscopy, and replication electron microscopy. The result of the aging treatment is a fine array of ω-phase particles with a mean center to center interparticle spacing of about 800Å. At an aging time of 300 hr the maximum onset critical current density is reached. The particle size at the maximum current density is about 420Å. At times longer than 300 hr effective particle impingement leads to lower onset critical current densities. (auth)

1102 OMEGA PHASE PRECIPITATION AND SUPERCONDUCTING CRITICAL TRANSPORT CURRENTS IN TITANIUM–22 AT. PERCENT NIOBIUM (COLUMBIUM). Kramer, David (Atomics International, Canoga Park, Calif.); Rhodes, Cecil G. Trans. Met. Soc. AIME, 239: 1612-15(Oct. 1967).

Critical transport currents were measured as a function of perpendicular external magnetic field in Ti–22 at. % Nb wire samples. These samples were heat-treated to yield ω phase precipitates at densities ranging from 10^{15} to 10^{17} cm^{-3}. The precipitates are ellipsoids of revolution with major axes of 50 to 1300 Å. Flux-pinning by ω precipitates is responsible for the high critical transport currents that were obtained. A sample cooled from 800°C and annealed 1 hr at 450°C carried a critical transport current of 10^5 amp per sq cm at 30 kG. Variations in the current-carrying ability of this alloy are due to changes in its pinning strength which is a function of precipitate density and composition and of the composition of the matrix. (auth)

1103 CHARGE DENSITY NEAR A VORTEX LINE IN TYPE-II SUPERCONDUCTORS. Leadon, R. (Univ. of California, San Diego, La Jolla). J. Phys. Chem. Solids, 28: 1093-8(July 1967).

A microscopic derivation is given for the charge density and electrostatic potential near a vortex line in type-II superconductors for which $\kappa \gg 1$. Numerical estimates of the distribution of density, potential, and electric field are calculated for a typical situation. (auth) (UK)

1104 MAGNETIC FIELD DEPENDENCE OF THE HIGH-FREQUENCY SURFACE RESISTANCE OF SUPERCONDUCTORS. Fischer, G.; Klein, R. (Laboratories RCA Ltd., Zurich). Solid State Commun., 5: 787-9(Oct. 1967).

The surface resistance R(H) of a superconductor in a magnetic field H can be smaller than R(0) for frequencies above the energy gap. This effect, recently suggested by Budzinski and Garfunkel, was demonstrated by reducing the gap by means of proximity effects. (auth) (UK)

1105 STRONG-COUPLING SUPERCONDUCTIVITY IN V_3X TYPE OF COMPOUNDS. Labbe, J.; Barisic, S.; Friedel, J. (Faculte des Sciences, Orsay, France). Phys. Rev. Lett., 19: 1039-41(Oct. 30, 1967).

The physical properties of high superconducting A_3B-type intermetallic compounds are calculated on the basis of d-band structure. Variations of the gap and the superconducting transition temperature with the number of electrons in the narrow d sub-band are shown. It is concluded that among the A_3B compounds all the situations between the strong- and weak-coupling limits of superconductivity can be expected. (A.G.W.)

1106 MICROWAVE ABSORPTION BY MAGNETIC-FIELD-INDUCED SURFACE STATES IN SUPERCONDUCTORS. Koch, J. F. (Univ. of Maryland, College Park); Pincus, P. A. Phys. Rev. Lett., 19: 1044-6(Oct. 30, 1967).

Tracings of the microwave absorption derivative in superconducting In are shown. Characteristic of such data is the pronounced peak followed by a regime of fields where the absorption decreases with increasing field applied parallel to the surface. The observations are interpreted in terms of quasi-particle states bound by the Meissner currents to the surface of the sample. The experimental behavior of the peaks is shown to be consistent with a mechanism involving transitions from thermally excited surface quasi-particle states into the BCS continuum. (A.G.W.)

1107 SUPERCONDUCTING MAGNETS IN HIGH-ENERGY PHYSICS. Derrick, M. (Argonne National Lab., Ill.). Science, 158: 325-31(Oct. 20, 1967).

The principles of superconductivity and the properties of the most-used superconducting materials are reviewed. Superconducting magnets built at Argonne National Laboratory for use with bubble chambers are described. Applications of superconductors in beam-transport magnets and special small-bore very-high-field detector magnets are discussed briefly. Unsolved problems in the field are pointed out, but it is concluded that most of the early difficulties have been overcome and the application of superconducting magnets to high-energy physics is expected to grow rapidly. (A.G.W.)

1108 ELECTRON TUNNELING MEASUREMENTS ON Pb NEAR THE TRANSITION TEMPERATURE. Franck, J. P.; Keeler, W. J. (Univ. of Alberta, Edmonton, Can.). Phys. Rev., 163: 373-5(Nov. 10, 1967).

The normalized conductance $\sigma = (di/dv)_s/(di/dv)_h$ of Pb/insulator/Al tunnel junctions and the gap at the gap edge, $\Delta_0(t)$, of Pb were determined for reduced temperatures in the range $0.92 \leq t \leq 1$. The results are compared with a theory of strong-coupling superconductors at nonzero temperatures due to Scalapino, Swihart, and Wada. The normalized conductance is in good over-all agreement with theory. Predicted structure due to electron-quasiparticle recombination is much smaller than calculated and possibly entirely absent. Near T_c a linear variation of $\Delta_0^2(t)$ with t is found; the slope of this line as measured is $d[\Delta_0(t)/kT_c]^2/dt = 14.6 \pm 0.3$, in excellent agreement with theory. (auth)

1109 EFFECT OF THE SUPERCONDUCTING ENERGY-GAP ANISOTROPY ON THE THERMAL CONDUCTIVITY OF TIN. Gueths, J. E.; Clark, N. N.; Markowitz, D.; Burckbuchler, F. V.; Reynolds, C. A. (Univ. of Connecticut, Storrs). Phys. Rev., 163: 364-72(Nov. 10, 1967).

Measurements of the normal- and superconducting-state thermal conductivities (K^n and K^s) were made on one pure and eleven cadmium-doped tin single crystals in the temperature range $1° < T < 4°K$. Cadmium concentrations ranged from 5×10^{-3} to 0.3 at. %. The crystal orientations are tightly grouped in the near-perpendicular direction (direction of heat flow approximately perpendicular to the tin tetrad axis). The fractional change of the lattice conductivity, K_g^s, in the superconducting state and an effect in the electronic part of the conductivity K_e^s, reflecting the anisotropy of the superconducting energy gap, are studied as a function of impurity concentration. The variation of the size of the anisotropy effect with electron mean free path is found to be in reasonable agreement with the theoretical predictions of Ulbrich et al. and the ultrasonic attenuation results of Claiborne and Einspruch. However, the magnitude of the anisotropy effect in tin is found to be approximately twice as large as that predicted by theory. Unsuccessful attempts to bring the theoretical calculations into agreement with experiment by altering the angular features of the energy-gap function are discussed. The variation of α, the temperature coefficient of the electron-phonon scattering term in the thermal resistivity expression, was studied as a function of impurity concentration and found to increase monotonically with concentration. Also the anisotropy of β, the temperature coefficient of the impurity scattering term, is shown to be similar to that of the residual resistivity. From the measured values of the residual resistivity, ρ_0, and β's obtained from the normal-state thermal conductivities, the Lorentz number L_0 was found to be $L_{exp} = 2.49 \pm 0.08$ for these samples. (auth)

1110 SURFACE DEPENDENCE OF THE CRITICAL PINNING CURRENT DENSITY IN TYPE-II SUPERCONDUCTING FOILS. Joiner, W. C. H.; Kuhl, G. E. (Univ. of Cincinnati). Phys. Rev., 163: 362-4(Nov. 10, 1967).

Measurement of flux-flow curves in cold-worked Pb–Bi type-II superconducting foils indicates that for samples otherwise prepared in the same way, J_p, the critical current density required to initiate flow, is linear in the surface-to-volume ratio of the samples. This and other surface effects suggest that, for these samples, pinning is almost entirely at the surface. Surface irregularities as well as mechanical defects act as sources of surface pinning. Changes in these pinning sources, achieved either through modifying the method of sample preparation or by annealing the samples, change the slope of the curve of J_p versus surface-to-volume ratio. The results are discussed in terms of Pearl's theoretical model in which the electromagnetic region of a fluxoid spreads at the sample surface. (auth)

1111 ISOTOPE EFFECT IN SUPERCONDUCTING γ-URANIUM ALLOYS. Hill, H. H.; White, R. W.; Lindsay, J. D. G.; Fowler, R. D.; Matthias, B. T. (Los Alamos Scientific Lab., N. Mex.). Contract W-7405-eng-36. Phys. Rev., 163: 356-61 (Nov. 10, 1967). (LA-DC-8849).

The isotope effect in stabilized γ-uranium alloys was measured and found $T_c \propto M^{\alpha}$, $\alpha = -0.53 \pm 0.02$. $T_c \approx 2.1°K$ is a more representative value for the extrapolated superconducting transition temperature of a hypothetical pure γ-uranium than the previously reported estimate of 1.8°K. (auth)

1112 FREE ENERGY OF JOSEPHSON JUNCTIONS. Ngai, K. L.; Appelbaum, Joel A.; Cohen, Morrel H.; Phillips, J. C. (Univ. of Chicago). Phys. Rev., 163: 352-5(Nov. 10, 1967).

Zawadowski has questioned the validity of the tunneling-Hamiltonian method for calculating simultaneously the amplitudes J_0 and E_0 of the zero-bias supercurrent and phase-coupling barrier energy. It is found that Zawadowski's Green's-function method leads to results which, to lowest order in the tunneling coupling constant T, i.e., T^2 agree with those previously obtained. The $T^2(\ln T)^{-1}$ corrections to the ratio J_0/E_0 predicted by Zawadowski's method are found to be spurious. (auth)

1113 MOTION OF MAGNETIC FLUX THROUGH SUPERCONDUCTING STRIPS. Houston, W. V.; Smith, D. R. (Rice Univ., Houston, Tex.). Phys. Rev., 163: 431-4(Nov. 10, 1967).

A torsion pendulum was used to measure mechanically the energy dissipation occurring in strips and vacuum-deposited films of indium as a function of the velocity with which they moved through a magnetic field normal to their surfaces. No dissipation was observed either above or below T_c when the strips moved through a uniform field. Below T_c, energy dissipation occurred in both the strips and the films when they moved through localized fields, and it was an order of magnitude greater than in the normal state. The energy loss below T_c contains a part proportional to the velocity and a velocity-independent part. An analysis of the velocity-dependent part of the losses indicates good agreement with the theoretical considerations of Bardeen and Stephen. (auth)

1114 PARTICLE-SIZE EFFECTS ON NUCLEAR MAGNETIC RESONANCE IN SUPERCONDUCTORS. Wright, Fulton Jr. (Univ. of California, Berkeley). Phys. Rev., 163: 420-31 (Nov. 10, 1967).

The Knight shift in the superconducting state has been observed in samples containing various sizes of small tin particles. The three main samples were constructed by vacuum evaporation of alternate layers of metal and dielectric (silicon monoxide). The particles are in the form of platelets whose diameter and thickness were measured with an electron microscope. The geometric means of the particle dimensions were 170, 300, and 570 Å. The fractions of the normal-state shift (referred to α tin) remaining at zero temperature were 84, 74, and 62%, respectively. Three other samples produced by a variety of processes gave results consistent with those of the main samples. The data fit well the theory of spin-reversing scattering through spin-orbit coupling which had been proposed to explain the nonzero Knight shift in superconductors. Two other possible contributions, a shift due to Van Vleck-type orbital susceptibility and crystalline-field spin-orbit coupling, cannot be ruled out theoretically, but do not appear to be important experimentally. (auth)

1115 INTERNAL-FRICTION AND YOUNG'S-MODULUS VARIATIONS IN THE SUPERCONDUCTING, MIXED, AND NORMAL STATES OF NIOBIUM. Kramer, Edward J.; Bauer, Charles L. (Carnegie Inst. of Tech., Pittsburgh). Phys. Rev., 163: 407-19(Nov. 10, 1967).

Internal-friction and Young's-modulus measurements have been performed on as-grown and deformed niobium single crystals as a function of temperature and external magnetic field. The crystals are driven in longitudinal resonance between 1.5 and 10°K at 80 and 240 kHz. An internal-friction relaxation peak is observed at 3.24°K in the superconducting state, but shifts abruptly to 2.08°K when the mixed state is established. This peak is characterized by a single relaxation time τ, defined by the expression $\tau = \tau_0 \exp(E/kT)$. The activation energy E and the attempt frequency τ_0^{-1}, respectively, are 0.0019 eV and 6×10^8 rad/sec in the superconducting state, and 0.0016 eV and 4×10^8 rad/sec in the normal state (k is Boltzmann's constant and T denotes the absolute temperature). Effects of plastic deformation and residual-impurity content suggest that the relaxation process involves the motion of dislocations, modified by the presence of residual chemical impurities. Based on this premise, the interaction between dislocations and magnetic fluxoids is inferred to be attractive. Young's modulus also reflects the relaxation, and, in addition, decreases with decreasing temperature below 4°K. This decrease, however, is not consistent with ordinary relaxation mechanisms. (auth)

1116 QUANTUM THEORY OF SUPERFLUID VORTICES. II. TYPE-II SUPERCONDUCTORS. Fetter, Alexander L. (Stanford Univ., Calif.). Phys. Rev., 163: 390-400(Nov. 10, 1967).

The London model of bulk type-II superconductors is used to derive the dynamical equations of quantized flux lines. These equations are rewritten in a Hamiltonian form, and the system is quantized by interpreting the conjugate variables as quantum-mechanical operators that obey the canonical commutation relations. Diagonalization of the Hamiltonian yields the exact dispersion relation for small-amplitude waves propagating with arbitrary wave vector in the vortex lattice. This formalism allows a straightforward calculation of the specific heat associated with thermally excited lattice vibrations and of the mean-square displacement of the vortex cores. Similar features are shown to occur in the mixed state of a thin superconducting film in a perpendicular magnetic field. (auth)

1117 SUPERCONDUCTING TRANSITION TEMPERATURES OF SEMICONDUCTING $SrTiO_3$. Koonce, C. S. (Univ. of California, Berkeley); Cohen, Marvin L.; Schooley, J. F.; Hosler, W. R.; Pfeiffer, E. R. Phys. Rev., 163: 380-90(Nov. 10, 1967).

The superconducting transition temperature T_c of $SrTiO_3$ has been measured for specimens having electron carrier concentrations n_c from 6.9×10^{18} to 5.5×10^{20} cm^{-3}. The curve exhibits a maximum in T_c for n_c near 9×10^{19} cm^{-3}. The transition temperature has also been calculated using one adjustable parameter ξ, the intervalley deformation potential, in addition to the known normal-state properties of $SrTiO_3$. A good fit to the experimental curve is obtained. (auth)

1118 PROPERTIES OF VORTEX LINES IN SUPERCONDUCTING BARRIERS. Lebwohl, P.; Stephen, M. J. (Yale Univ., New Haven). Phys. Rev., 163: 376-9(Nov. 10, 1967).

There are two qualitatively different types of solution to the Josephson barrier equations. The first type corresponds to vortex lines in the barriers. For small damping, a rather complete picture of vortex line motion can be obtained including inertial and dissipative effects. The second type of solution corresponds to plasma oscillations. The stability of the solutions is investigated and results are obtained for the collective modes of the vortex lines and the propagation of plasma oscillations in a magnetic field. (auth)

1119 RUGGED FINE-WIRE SUPERCONDUCTING FIELD PROBE. Gayley, R. I. (State Univ. of New York, Buffalo). Cryogenics, 7: 215-18(Aug. 1967).

A magnetic field probe, based on the resistance of a strip of partially superconducting material, has been made by coating either tin or indium on to one side of a fine copper wire. The resulting devices were small, rugged, flexible, and gave an accuracy of a few gauss in the 5- to 100-G range. Details of the probe construction are given, along with typical calibration data and some representative experimental results obtained with such a probe. The temperature dependence of the calibration was not as great as might be expected, the width of the superconducting transition being 0.5 and 1.0°K for the two probes described, and was not a serious disadvantage for our application. (auth)

1120 A VARIABLE-TEMPERATURE LIQUID HELIUM STAGE FOR METALLOGRAPHIC STUDIES OF SUPERCONDUCTING MATERIALS. King, H. W.; Pollock, J. T. A. (Imperial Coll. of Science and Tech., London). Cryogenics, 7: 209-14 (Aug. 1967).

A low-temperature optical stage is described which incorporates a Nachet metallurgical microscope. By providing the optical window with a sliding adjustment, objectives with numerical apertures up to 0.55 may be used, permitting magnifications up to × 1000, under interference contrast conditions, at temperatures down to 6.5°K. Superconducting transition temperatures of samples mounted in the cold stage can be measured by the ac inductance method. The effectiveness of the microscope is demonstrated by examining and measuring surface relief effects in partially transformed copper–aluminum–manganese and iron–nickel alloys at 77 and 6.5°K, respectively. Single and polycrystalline samples of Al 5 superconductors examined in the cold stage show no surface relief effects at 6.5°K. This negative result is discussed in relation to previous reports of low-temperature phase transformation in these materials, based on x-ray topography, electron microscopy, and ultrasonic attenuation. (auth)

1121 SUPERCONDUCTING BOLOMETER CURRENT MODULATOR. Vtorov, E. P.; Dmitrenko, I. M. (Physical-Technical Inst. for Low Temperatures, Kharkov). Cryogenics, 7: 207-8(Aug. 1967).

A measuring amplifier for dc voltage is described, having a sensitivity of 10^{-11} V; it uses a superconducting bolometer modulator, which appreciably simplifies the apparatus and standard equipment. The temperature variation of the resistance of a single crystal of very pure cadmium was measured below 3.7°K with high accuracy. (auth)

1122 HEAT CONDUCTIVITIES BELOW 1°K. II. Sharma, J. K. N. (Oxford Univ.). Cryogenics, 7: 195-9(Aug. 1967).

The Bardeen, Rickayzen, and Tewordt theory of thermal conductivity of superconductors (BRT) based on the BCS theory was used to analyze the heat conductivity results on aluminum, tantalum, and rhenium. The results, in general, are in good agreement with BRT. The temperature variation of the energy gap is in accord with the BCS scheme of the reduced energy gap. The value of the energy gap at absolute zero for aluminum, as suggested by the heat conductivity results, is $2\epsilon_0(0) = 3.52\ \kappa T_c$ which is the BCS value of the energy gap for all superconductors. The value of the energy gap for tantalum $2\epsilon_0(0)$ is $3.60\ \kappa T_c$ and the BRT function for lattice conductivities has been used to calculate the contribution of the lattice conductivity K_{gs} to the normal state thermal conductivity (K_n) of tantalum which is less than 0.5%. An observation of Zavaritskii that the electronic thermal conductivity of superconductors can be represented by an empirical relation $K_s = \exp[-b(T_c/T)]$ has been used to estimate the value of the energy gap at an absolute zero for rhenium. The value of energy gap for rhenium is $2\epsilon_0(0) = 3.30\ \kappa T_c$. (auth)

1123 MELTING PHENOMENA IN SOLIDIFIED GASES. Gopal, E. S. R.; Vaidya, S. N.; Gambhir, R. D.; Govindarajan, K. (Indian Inst. of Science, Bangalore). J. Indian Inst. Sci., 49: 61-70(Apr. 1967).

Based on the Lindemann melting criterion and the Gruneisen equation of state, a melting law $\log (T_m/T_m^0) = 2(\gamma - \frac{1}{3}) \log (v_0/v)$ is derived, which for small compressions gives a linear relation between T_m and $|\Delta v/v_0|$ as suggested recently by Kraut and Kennedy. The correlation between T_m and $|\Delta v/v_0|$ holds good very satisfactorily for the high-pressure data on the following solidified gases: ^3He, ^4He, Ne, Ar, Kr, Xe, H_2, D_2, N_2, O_2, NH_3, CO_2, CH_4, C_2H_4, C_2H_6, and C_3H_8. The Gruneisen constant γ calculated from the melting equation agrees well with the values calculated independently from thermal measurements, where they are available. In ^4He and H_2, the decrease of γ at high compressions along the melting line is noticeable and agrees with the other thermal measurements. The present equation relates melting phenomena in a quantitative way with general solid-state studies. (auth)

1124 POWER TRANSFER TO FINITE PLASMAS NEAR THE LOWER HYBRID RESONANCE. Oakes, M. E.; Schluter, H.; Skipping, R. (Univ. of Texas, Austin). Phys. Lett., 25A: 482-3 (Sept. 25, 1967). (ORO-3110-9).

The features of dispersion relations in the range of the lower hybrid resonance in the case of finite plasma cylinders are discussed. The possibility of two optima in the power transfer or of a broad transfer band is pointed out. (auth)

1125 THE MIXED-STATE THERMAL CONDUCTIVITY OF CLEAN AND DIRTY TYPE-II SUPERCONDUCTORS. Lowell, J.; Sousa, J. B. (Clarendon Lab., Oxford). Phys. Lett., 25A: 469-70(Sept. 25, 1967).

The thermal conductivity of a clean type-II superconductor is found to approach the normal-state value with infinite slope at H_{c2}, in agreement with a recent prediction and in contrast to the behavior of dirty materials. (auth)

1126 ENHANCEMENT OF SUPERCONDUCTIVITY IN TUNGSTEN FILMS. Chopra, K. L. (Kennecott Copper Corp., Lexington, Mass.). Phys. Lett., 25A: 451-2(Sept. 25, 1967).

The observed enhancement of superconductivity in fine-grained tungsten films is attributed to structural changes. (auth)

1127 NEW MEASUREMENT OF THE ENERGY GAP IN SUPERCONDUCTING NIOBIUM. Bonnet, D.; Erlenkaemper, S.; Germer, H.; Rabenhorst, H. (Batelle-Institut e.V., Frankfurt am Main). Phys. Lett., 25A: 452-3(Sept. 25, 1967).

The energy gap of superconducting niobium has been determined by tunneling experiments to be 2.32 MeV. (auth)

1128 PHOTO-EJECTION OF ELECTRONS FROM BUBBLE STATES IN LIQUID HELIUM II. Northby, Jan Arwood. Minneapolis, Univ. of Minnesota, 1966. 156p.

Thesis.

Observation of the photoejection of electrons trapped in bubble states in liquid helium is reported. Detection of this effect offers very direct evidence of the validity of the bubble model. An electron that spends part of the time untrapped should have a higher average drift velocity in an electric field than one that remains in a bubble. A time-of-flight apparatus was used to detect changes in the drift velocity of electrons when they are exposed to radiation in the one-micron region. An effective cross section was measured as a function of light wavelength. The experimental curves are compared with cross sections calculated for spherical square wells of various depths and radii. If the current experimental value of the well depth is used, agreement with theory is found if the bubble radius is either 14.90 ± 0.30 Å, or 20.55 ± 0.35 Å. These results are in reasonable agreement with previous theoretical and experimental estimates. The observed magnitude of the effect is also consistent with theory. (Disser. Abstr.)

Plasma and Thermonuclear Physics

Refer also to abstracts 1130 and 1254.

1129 (LA-3770) PROCEEDINGS OF THE AMERICAN PHYSICAL SOCIETY TOPICAL CONFERENCE ON PULSED HIGH-DENSITY PLASMAS HELD AT THE LOS ALAMOS SCIENTIFIC LABORATORY OF THE UNIVERSITY OF CALIFORNIA,

LOS ALAMOS, NEW MEXICO, SEPTEMBER 19–22, 1967. (Los Alamos Scientific Lab., N. Mex.). Sept. 29, 1967. Contract W-7405-eng-36. 329p. (CONF-670928). Dep. CFSTI.

Separate abstracts were prepared for 54 of the 58 included articles. For abstracts of the 4 remaining papers see CONF-670928 in the report number index. (M.O.W.)

For abstracts of individual papers see: 1131–1142, 1155–1159, 1179–1195, 1249–1258, 1264–1269, and 1279–1282.

1130 TECHNICAL REPORT OF THE INFORMATION MISSION MADE IN THE USSR FROM FEBRUARY 12–23, 1967, ON THE INTERACTIONS BETWEEN OSCILLATING FIELDS AND PLASMAS. Briffod, G.; Consoli, T.; Geller, R.; Legardeur, R. Bull. Inform. Sci. Tech. (Paris), No. 116, 3-64(June 1967). (In French).

The laboratories visited during this visit were: The laboratories of Doctors Osovets and Glagolev and of Professor Zavoisky at the Moscow Kurchatov Institute, the laboratories of Professors Silin, Spiegel and Rabinowitch at the Moscow Lebedev Institute, the laboratories of Professors Tolok and Fainberg at the Ukrainian Physico-technical Institute at Kharkov, and the laboratory of Professor Demirkanov at the Georgian Physico-Technical Institute at Sukhumi. The research at the Osovets lab. was on the dynamic stabilization of a linear discharge and the heating and confinement by the oscillating magnetic field of a progressive wave. At the Glagolev lab. hf heating of plasma, confinement and stabilization by hf fields, and configuration research at oscillating minimum B are being studied. Professor Zavoisky is studying heating of plasma by magnetoacoustical waves, heating by shock waves without collision, heating of the plasma by instabilities, and theory and diagnostics of these heatings. At the Lebedev Inst. labs. studies are being made on the nonlinear interaction of hf fields with plasma, heating of plasma at the cyclotron frequency of the electrons, study of the plasma movement in the electromagnetic potential of a stationary or progressive field, and interaction of a laser beam with microgranules. At the Ukrainian Inst. Professor Tolok is studying ionic heating of a plasma, heating at hybrid frequency, and heating at the cyclotron resonance of the ions. Professor Fainberg was studying beam–plasma interactions, the instabilities created in this interaction and their suppression, and correlations. Professor Demirkanov was studying the dynamic stabilization of a linear discharge by a turning magnetic field in the presence of static magnetic field, dynamic stabilization of a colloidal discharge by an oscillating and moving magnetic field in the presence of a static magnetic field, and heating of a plasma by beam-plasma interaction. The article "Utilization of High Frequency Electromagnetic Fields to Confine and Stabilize a Plasma" by Dr. Osovets appearing in Atomnaya Energia, 15: 1-12(October 1963) was cited in full as an introduction to the experimental work being carried out in the Osovets laboratory. The general trends in the laboratory of Dr. Osovets are improvement of existing theories with approach toward nonlinear effects; improvement of the diagnostics by a better understanding of the phenomena; increase of the power, pulses, and frequencies; and studies on insulators with low loss. The position and point of view of Doctor Glagolev are summarized and a characteristic experiment of his laboratory—paramagnetic effect due to the pressure of radiation and parametric resonance of the electrons in a plasma—is described. The laboratory of Professor Zavoisky is oriented toward study of collective interactions in plasma. Only a brief summary is given of the work being done at the Lebedev Inst. The primary activity of the Tolok group is based on the cyclotron heating of ions. Three machine types of this genre are described. The studies made at Kharkov on the beam–plasma interactions are marked by the close cooperation between theoreticians and experimenters. Results obtained on nonmodulated beams, modulated beams, and with dense plasmas are briefly reported. Most of the research at the Georgia Inst. is on oscillating field–plasma and beam–plasma interactions. The research philosophies in these laboratories are summarized and experimental devices and results obtained are briefly reported. The information received from this visit showed that the French delegation had underestimated the extent and state of advancement of the Soviet studies on plasma physics and the interaction of hf fields with plasma. A bibliography is given of Soviet publications in this field. (J.S.R.)

Confinement and Heating of Plasma

1131 (LA–3770, Paper G1) THE 15-METER SCYLLAC THETA PINCH. Kemp, E. L.; Quinn, W. E.; Ribe, F. L.; Sawyer, G. A. (Los Alamos Scientific Lab., N. Mex.). 6p.

The Scyllac θ pinch is being designed in two phases: a 15-m linear device, followed later by a 5-m diameter torus. These will successively occupy a common building, power supply, and control system. Engineering progress in designing the large system is described, as well as component development of the basic 60-kV, 2-μF capacitor, the coaxial cables, and the "start" and "crowbar" switches. The "M and S," or free-boundary, problem of toroidal plasma equilibrium has been solved to first order in the aspect ratio of the plasma torus, yielding equilibrium solutions for thin-skinned plasmas with and without internal magnetic fields. Actual coil configurations to produce corresponding transverse stabilizing fields of $l = 0$ and $l = 1$ azimuthal symmetry with suitable longitudinal wavelengths have been constructed and measured. Corresponding experiments with $l = 0$ and $l = 1$ "bumps," excited at the center of the 100-cm Scylla IV compression coil, are being carried out to study ballooning-instability growth rates and practical problems of transverse field excitation. (auth)

1132 (LA–3770, Paper A5) MEASUREMENT OF PLASMA DENSITY AND PARTICLE LOSSES IN A LARGE THETA PINCH. McLean, E. A.; Anderson, A. D.; Griem, H. R. (Naval Research Lab., Washington, D. C.). 5p.

Particle containment times (~25 μsec) have been measured in $\beta \simeq 0.4$ to 0.5 and $\beta \simeq 1$ plasmas produced with initial reverse fields. Flow through the constricted ends of the dense plasma column does not always account for the observed particle loss rate. However, there is direct photographic evidence for plasma leaving the coil region along the field lines, presumably after radial diffusion across field lines along the plasma column. This radial diffusion is found to be slower than Bohm diffusion by an order of magnitude (or more) for $\beta \simeq 1$. In another experiment with a larger tube diameter and a lower β, after the first 10 to 15 μsec the loss time is consistent with "Bohm times" of $\tau \sim r^2/4D_B$. The loss rate during the first 10 to 15 μsec appears to be considerably lower but has not yet been established quantitatively. (auth)

1133 (LA–3770, Paper B4) TWO-DIMENSIONAL EQUILIBRIUM FOR HIGH-BETA MIRROR DEVICES INCLUDING PARTICLE LOSS. Grossmann, W. Jr.; Freidberg, J. P. (New York Univ., N. Y. Courant Inst. of Mathematical Sciences). 3p.

Two-dimensional equilibrium for high-beta mirror devices are found by solving the Vlasov equation and Amperes law self-consistently. Particle loss is taken into account self-consistently by allowing particles to exist only outside of the local loss cone angle. It is found that for a given set of plasma parameters and applied mirror ratio that (1) solutions only exist below some critical value of β, (2) in certain cases the solutions show a non-uniqueness related to the question of stability. (auth)

1134 (LA–3770, Paper B5) THETA-PINCH LOSS RATE ASSOCIATED WITH HIGH-BETA COLLISIONLESS EQUILIBRIUM CONFIGURATIONS. Kilb, Ralph W. (General Electric Co., Schenectady, N. Y. Research and Development Center). 6p.

Numerical studies of equilibrium configurations in a collisionless high-β θ pinch showed that some regimes did not have solutions. A guiding center fluid approach was used with $P_\perp(B)$ and $P_\parallel(B)$. With $\beta > 0.3$ and an empty loss cone, solutions could not be found, apparently because the plasma did not satisfy the ellipticity condition $\partial/\partial B[P_\perp(B) + B^2/8\pi] > 0$. This criterion is closely related to the "mirror instability" which occurs when $P_\perp/P_\parallel$ is too large. However, numerical solutions can be found when the loss cone is populated to a minimum level which will satisfy the ellipticity criterion. From the required loss cone population, one may compute an e-folding loss time τ, which yields $\tau \sim 1$ μsec for our θ pinch. This compares with an experimental $\tau \sim 1.8$ μsec during the high-β phase of the pinch. It is speculated that during the high-β phase some microinstability (perhaps of the Post–Rosenbluth loss cone type) continuously fills the loss cone. The associated high loss rate may stop when the plasma-β falls to ~$\frac{1}{4}$, where ellipticity is satisfied with zero loss cone level. This late stage may correlate with the second quarter cycle of our θ pinch where the neutron yield and end loss measurements seem to indicate better containment after the plasma-β and density have fallen sharply. (auth)

1135 (LA–3770, Paper B8) TURBULENT HEATING OF A SHOCKED MAGNETIZED PLASMA. Mawardi, O. K.; Scott, R. M. (Case-Western Reserve Univ., Cleveland, Ohio). 5p.

Investigations were made on the observed heating of the plasma downstream of the shock. This anomalous behavior is ascribed to an ion–ion two-stream instability which causes the onset of turbulence in the plasma. The turbulent character of the shock is inferred from the thickness of the shock front and diffusion of the trapped magnetic field. Comparison of theory with experiments is discussed. (auth)

1136 (LA–3770, Paper D1) ION HEATING IN THE EARLY STAGES OF A VERY FAST THETA PINCH. Schumacher, U.;

Wilhelm, R.; Zwicker, H. (Institut fuer Plasmaphysik, G.m.b.H., Garching (West Germany)). 4p.

In a theta pinch with fast rising magnetic field (dB/dt = (1.3 to 2.1) × 10^{11} G/s) ion energies in the keV region were obtained already after the first compression. At filling pressures of 20 mtorr these energies were indicated by neutron production at the end of the implosion. The velocity distribution function of the ions seems to be nearly monoenergetic. Probe measurements during the implosion show that the current carrying layer decreases with increasing filling pressure (10 to 60 mtorr D_2). The axial region, however, remains free of field up to the first compression. (auth)

1137 (LA-3770, Paper D3) MEASUREMENT OF THETA-PINCH END LOSS USING A GAS LASER INTERFEROMETER. Thomas, K. S. (Los Alamos Scientific Lab., N. Mex.). 5p.

A He–Ne gas laser interferometer has been used to make plasma density measurements outside the central plasma core of a θ-pinch plasma. At the θ-pinch coil midplane, the average plasma density is less than the sensitivity of the interferometer, that is, less than 5×10^{13}cm^{-3}. Outside the ends of the coil line densities (particles per cm of tube length) of the order of 10^{15}cm^{-3} are measured. When compared to previous data from the same θ pinch, a streaming velocity out the coil ends in the neighborhood of the ion thermal velocity is obtained. (auth)

1138 (LA-3770, Paper D7) INFLUENCE OF STRONG MAGNETIC MIRRORS ON THE STABILITY AND CONTAINMENT OF A THETA-PINCH PLASMA. Heiss, A.; Herold, H.; Unsoeld, E. (Institut fuer Plasmaphysik, G.m.b.H., Garching (West Germany)). 5p.

Magnetic mirrors with R = 1.1, 1.6, and 3.1 are applied to a theta pinch coil (30-cm long) fed by a 80-kJ bank. The resulting plasma properties are compared with those of a mirrorless coil at various filling pressures (10 to 50μ Hg, D_2). The application of mirrors does not cause detectable instabilities during the time of observation (5 μsec ≈ T/2) provided that the mirror region is not too short. Rotational instabilities are observed occasionally in cases with mirror coils as well as with mirrorless coils, especially at higher filling pressures. The interferometrically determined particle number in the mirror coils shows an initial phase with reduced losses due to axial compression followed by a time of exponential decay which lasts up to the end of the half wave. The e-folding times are compared with those predicted by loss models for collisionless and collision dominated outflow and with those obtained from numerical two-dimensional magnetohydrodynamic one-fluid computations. The results of the 3 loss models differ only slightly and there is good agreement with the experimentally observed e-folding times. For scaling purposes $t_N \sim R \times l/T_i^{\frac{1}{2}}$ is found to be a good approximation for theta pinch plasmas characterized by a m.f.p. of the ions from 10 to 1000 cm, T_i = 2 to .5 keV and β = .3 to .8. (auth)

1139 (LA-3770, Paper E1) IMPULSION HEATING OF PLASMA IN THE BILLE-EN-TETE EXPERIMENT. Evrard, P.; Jacquinot, J.; Leloup, C.; Poffe, J. P.; de Pretis, M.; Waelbroeck, F. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). 6p.

A plasma column ($v_0 < 5.10^6$ cm.s^{-1}, diameter ≈ 4.5 cm) is injected along the axis of a simple magnetic bottle (mirror ratio 1.7) and heated by a fast condenser bank (0.5 μF, ≤ 100 kV) discharged into a single turn coil (ϕ = 16 cm, l = 40 cm) surrounding the plasma. During the first quarter-period (0.4 μsec), the initially static magnetic field (usually 1700 gauss) decreases; the plasma expands; the field reincreases rapidly thereafter; during this recompression phase, plasma heating is observed. After the first half cycle, the circuit is crowbarred. The initial plasma parameters were varied between: 10^{13} cm^{-3} > n > 10^{12} cm^{-3}; 5 eV < T_e < 15 eV; 10 eV < T_i < 150 eV. After the heating, hot ions ($T_i \simeq 400$ eV) and electrons (T_e = 12 ± 3 keV) are detected. The radius is 2 cm and the plasma volume is about 1.5 liter. The ions disappear in a few tens of μsec. During their lifetime, the plasma appears turbulent and noisy. At lower densities, the hot electron population decays regularly ($\tau_{1/e} \geq 1$ msec). At higher densities, τ is still several hundreds of μsec, but sporadic bursts of instabilities are detected leading simultaneously to: large plasma energy losses; a decrease of the pressure anisotropy; radial and axial electron losses; strong polarized emission at ω_{c_e} and at higher frequencies; and rapid flute-like motions of the plasma column. Two different types of instability are distinguished. (auth)

1140 (LA-3770, Paper G4) "LONG-CUSP" CONTAINMENT EXPERIMENT. Allen, T. K.; Coxell, H.; Hill, M.; Spalding, I. J. (United Kingdom Atomic Energy Authority, Abingdon (England). Culham Lab.). 6p.

A cusp-ended theta-pinch experiment (CENTAUR) is described. The 100-kV θ pinch, 50 cm long and of coil diameter 19 cm, reaches a peak field of up to 21 kG in 2.1 μsec. The cusps are energized at either end independently to give fields of up to 40 kG and 65 kG at the ring and spindle cusps respectively, with a rise time of 2.1 μsec. Both the cusp and θ-pinch fields fall to some 70% of their peak value in 15 μsecs. The stability and containment time of a simple θ pinch is examined for various values of β. At low β an m = 1 instability is predicted and observed, but at high β the plasma appears to be stable, in agreement with theory. Plasma temperatures and densities are typically 150 eV and 10^{16} cm^{-3} in these experiments, and so the calculated Bohm pumpout time is significantly less than the β = 1 collision-free loss time through an ion gyro radius hole. The observed containment times are consistent with Bohm diffusion (in common with other published θ-pinch experiments), but this interpretation is not unique in the present experiment until β has been measured with greater accuracy. Preliminary observations with the cusps are described. (auth)

1141 (LA-3770, Paper G5) HARD-CORE THETA PINCH WITH REVERSE TRAPPED MAGNETIC FIELD. Kolb, A. C.; Young, M. P.; McLean, E. A. (Naval Research Lab., Washington, D. C.). 6p.

A rotating flute instability has previously limited the confinement time in Pharos to ~15 μsec. The experiment has been modified by (a) increasing the quartz tube i.d. from 8.7 cm to 17 cm, (b) increasing the main bank energy from 1.3 MJ to 2 MJ, and (c) inserting a 4-cm-diameter insulated conductor on the axis, connected to a 700-kJ, 100-kV capacitor bank (a clamped 5-stage Marx generator). The relevant design parameters are: B_t = 80 kG, rise time 25 μsec, L/R decay time 200 μsec; B_0 = 50 kG at 3 cm from magnetic axis, rise time 25 μsec, L/R decay time 150 μsec. The experiment is designed to study high-shear, high-β plasma in a closed-field geometry. The confinement time without the hard core is considerably longer in the case of the larger tube. Preliminary results with 50 and 100 kJ of the hard-core capacitor bank show that the time the plasma is held off the rod increases with increasing hard core current. (auth)

1142 (LA-3770, Paper H4) THEORY OF INERTIAL CONFINEMENT OF DENSE PLASMAS. Linhart, J. G.; Maisonnier, Ch.; Somon, J. P. (Comitato Nazionale per l'Energia Nucleare, Frascati (Italy). Laboratorio Gas Ionizzati). 9p.

Cylindrical devices in which a central medium (such as a magnetic field or a deuterium plasma) is compressed by means of a collapsing liner, are considered. The liner is supposed to be either a metallic shell, accelerated by explosives, or a polytropic plasma shell, accelerated by magnetic pressure. The results of several studies on the dynamics of the motion are presented. They give in particular the efficiencies of the energy transfers from the external source to the liner and from the liner to the central medium the confinement time, and the maximum energy density attainable in the compression. (auth)

1143 (NYO-3863-1) QUARTERLY PROGRESS REPORT. (Avco-Everett Research Lab., Everett, Mass.). Oct. 1967. Contract AT(30-1)-3863. 22p. Dep. CFSTI.

Using the existing toroidal apparatus, an extensive series of experiments aimed at clarifying the detailed factors influencing charge injection was carried out. A new high-vacuum toroidal device for studying long-time containment of electron clouds is briefly described. (M.O.W.)

1144 (UCID-15230) THEORETICAL MODEL OF THE AXIAL CURRENT AND MAGNETIC FIELD DISTRIBUTION OF THE E-LAYER: COMPARING WITH EXPERIMENTAL RESULTS. Christofilos, N. C. (California Univ., Livermore. Lawrence Radiation Lab.). July 5, 1967. Contract W-7405-eng-48. 9p. Dep. CFSTI.

Calculations were made of the E-layer axial current and magnetic field distribution. (M.O.W.)

1145 (UCRL-70450) ASTRON APPROACH TO CONTROLLED FUSION. Christofilos, N. C. (California Univ., Livermore. Lawrence Radiation Lab.). Apr. 24, 1967. Contract W-7405-eng-48. 25p. (CONF-670414-4). Dep. CFSTI.

From Meeting of the American Physical Society, Washington, D. C.

The fundamental concepts of the Astron device for controlled fusion research are described. A general description of the facility is given. (M.O.W.)

1146 (UCRL-Trans-10133) FLUX-COMPRESSION GENERATORS. Bichenkov, E. I. Translated by T. Watt for Univ. of California Lawrence Radiation Lab., Livermore, from Dokl. Akad. Nauk SSSR, 174: 779-82(1967). 12p. Dep. CFSTI. JCL $1.60 fs, $0.80 mf.

The results of work done at the Hydrodynamics Institute of the Siberian Division of the USSR Academy of Sciences on the construction of explosion devices converting the energy of the ex-

plosives into the energy of a magnetic field are summarized. Several methods are described. (M.O.W.)

1147 PLASMA KINETIC THEORY OF TRANSVERSE DIFFUSION. Haggerty, M. J. (Polytechnic Inst. of Brooklyn, Farmingdale, N. Y. Univ. of Maryland, College Park). Phys. Fluids, 10: 2199-2215(Oct. 1967).

The kinetic theory of Prigogine and Balescu is applied to the diffusion of a plasma column across a uniform magnetic field. The problem of deriving the kinetic equation for the single-particle distribution function is reduced to that of solving a linear integral equation with a complicated kernel. No restriction is made on the amplitude or length scale of the inhomogeneity across the magnetic field. Although a multicomponent plasma is considered, the calculation ignores macroscopic electric fields. An unusual linearization of the Vlasov equation is also examined. It yields essentially the same linear integral equation, where the kernel represents a generalized electric susceptibility. The problem of finding the unstable modes of oscillation is the eigenvalue problem for the corresponding homogeneous integral equation. If the collective terms are replaced by appropriate cutoffs in the integrations, the kinetic theory becomes relatively simple. In particular, a single kinetic equation describes the collisional transverse diffusion. For a gyrotropic plasma with slab geometry, this kinetic equation reduces to one previously obtained by Elonskiĭ, Zyryanov, and Silin by a different method; an H theorem has been established, and some nonequilibrium stationary distributions have been found. (auth)

1148 TWO-DIMENSIONAL, TIME-INDEPENDENT SOLUTIONS FOR PLASMA MOVING THROUGH A UNIFORM TRANSVERSE MAGNETIC FIELD. Poukey, James W. (Univ. of Wisconsin, Madison). Phys. Fluids, 10: 2253-9(Oct. 1967).

If particle gyroradii and drift velocities are small in a collisionless plasma which is infinite and uniform in the direction of the straight magnetic field B, it may be shown in the time-independent case that particle densities and B are constant on any surface of constant electrostatic potential. Using the magnetohydrodynamic equation of motion, it follows that the particles move very nearly along these equipotential surfaces, and an expression for the charge density may be derived. From the resulting Poisson equation, solutions for plasma crossing a uniform B_0 field may be obtained; collectively these solutions may appropriately be termed the "double-vortex" model from their drift velocity patterns. (auth)

1149 ELECTRON-CYCLOTRON RESONANCE HEATING OF ALKALI PLASMAS. Levine, A. M.; Kuckes, A. F.; Motley, R. W. (Princeton Univ., N. J.). J. Appl. Phys., 38: 4435-40 (Oct. 1967).

A method has been developed for heating the electrons in a thermally generated alkali plasma by the resonant absorption of electromagnetic waves at the electron-cyclotron frequency. The electron temperature was increased from 0.2 eV to ~1.0 eV with the application of ~1 W of power at a frequency of 10 kMHz. Excellent consistency has been found between diamagnetic measurements of plasma pressure, microwave determinations of plasma density, and double-probe determinations of temperature. The observed temperature increases were in quantitative agreement with computations which consider the heat loss by thermal conduction. (auth)

1150 INERTIAL-ELECTROSTATIC CONFINEMENT OF IONIZED FUSION GASES. Hirsch, Robert L. (ITT Farnsworth Research Corp., Fort Wayne). J. Appl. Phys., 38: 4522-34(Oct. 1967).

The nonmagnetic, inertial-electrostatic confinement of ionized gases in spherical geometry is discussed theoretically, and associated experiments are described. Assuming monoenergetic ion and electron distribution functions, the Poisson equation for bipolar currents is solved numerically. The results indicate spatially periodic solutions which represent the alternate formation of virtual anodes and virtual cathodes. Particle pressures are found to vary approximately as the inverse square of the radius and extremely high electric fields are indicated. Near the center of the spherical cavity, there exists a high-density, high-energy region, which may be of controlled fusion interest. The experimental apparatus consists of a hollow spherical cathode concentrically placed within a spherical anode on which six ion guns are located. Steady, reproducible operation up to –150 kV and 60 mA yields a copious neutron emission, a part of which originates from a luminous spherical region within the cathode. After crowbar of the main power supply, approximately 10^{16} particles are released from within the cathode. This number is significantly greater than the 10^{12} to 10^{14} ions/cm^{-3} calculated from the fusion rate. The difference is attributed to the formation of two or more virtual anodes. A bremsstrahlung collimation study indicates a spatially periodic emission pattern, suggesting the formation of at least two virtual anodes, the outer of which is about 2.5 cm in diameter. No instabilities have been observed. (auth)

Diagnostics of Plasma

Refer also to abstracts 216 and 1137.

1151 (AD–646889) RESEARCH STUDIES OF HIGH-DENSITY PLASMAS. Quarterly Progress Report No. 8, June 15–September 15, 1966. Bialecke, E.; Vesely, E.; George, T. V.; Dreyer, L.; Dolan, T. (Illinois Univ., Urbana. Dept. of Electrical Engineering). Jan. 1967. Contract DA-28-043-AMC-00094(E). 39p. (ECOM–00094-8). CFSTI.

Experiments to determine the spatial and temporal variations of the electron distribution of the high-density plasma were made using a laser interferometer with increased sensitivity. Spatial and temporal determination of the conductivity of the plasma was continued using this method and is described. Experimental determination of the plasma resistance was made. Also, its variation was noted to changes in hydrogen gas pressure and different capacitor bank voltages. Further experiments were made to determine the effects on the plasma resistance when impurity gases such as neon, krypton and xenon were added to the hydrogen gas. (auth) (TAB)

1152 (AD–646891) ELECTRON-HEAVY PARTICLE NONEQUILIBRIUM IN A DENSE ARGON PLASMA. Interim Report, September 1, 1964–August 31, 1965. Report No. 763. Jacobs, Paul F.; Grey, Jerry (Princeton Univ., N. J. Dept. of Aerospace and Mechanical Sciences). July 1966. Contract AF33(657)-9962. 192p. (ARL–66-0143). CFSTI.

A theoretical and experimental study of the degree of electron heavy particle thermal nonequilibrium was conducted for a subsonic argon arcjet plasma at one atmosphere. A criterion for "electron-temperature freezing" was calculated, and indicated that although electron and heavy-particle temperatures were quite close to each other under typical arcjet environments, measurable departures should be observed at the lower temperature or density conditions. These analytical findings were verified quantitatively by simultaneous experimental measurements of the local electron temperature and heavy-particle temperature in the arcjet. These measurements were made with a unique water-cooled calorimetric–electrostatic probe. Proper interpretations of the electrostatic probe data in a dense plasma (argon at 1 atm) was verified by three accurate independent measurements (calorimetric, log current vs voltage, and saturation current ratio). It was also concluded that under certain (typical) conditions, the cooled electrostatic probe could provide a good approximation to the electron density in a dense plasma, and could provide an indication of plasma flow turbulence. (auth) (TAB)

1153 (IPP–1/66) EIN ELEKTROSTATISCHER ANALYSATOR ZUR MESSUNG DER ENERGIE VON IONEN UND ELEKTRONEN AUS HEISSEN PLASMEN. (An Electrostatic Analyzer for Measuring the Energy of Ions and Electrons from Hot Plasmas). Niedermeyer, Helmuth (Institut fuer Plasmaphysik, G.m.b.H., Garching (West Germany)). June 1967. 66p. (In German). Dep.

An electrostatic energy analyzer for recording the energy spectrum of plasma particles (electrons and positive ions) in the range of 10 eV to a few tens of keV is described. The resolution of the cylindrical capacitor used as energy filter can be set between 1 and 3%. The transmitted particle current is measured with a scintillation detector sensitive to ions or electrons depending on the applied electrode voltages (ions produce secondary electrons, which are detected with the scintillator). For a time resolution of 5 ns a particle current of 10^{-7} A is measured with a statistic error of 2%. The sensitivity of the detector was calibrated absolutely with both an electron and ion beam. Plasma particles are admitted to the analyzer through a highly evacuated, magnetically shielded tube system that can be placed to within a few centimeters of a high-temperature plasma. The calibration method and the electron and ion sources used for calibration are also described. (auth)

1154 (IPP–1/69) ON THE POSSIBILITY OF MEASURING MAGNETIC FIELDS BY SCATTERED LIGHT. Lehner, G.; Pohl, F. (Institut fuer Plasmaphysik, G.m.b.H., Garching (West Germany)). Aug. 1967. 17p. Dep.

In the case of uncorrelated electrons (i.e., $\alpha \ll 1$) the electron spectrum is modulated with the electron gyration frequency if a certain condition is fulfilled. The essential parameters are discussed and some spectra are computed numerically. (auth)

1155 (LA-3770, Paper A3) FARADAY ROTATION MEASUREMENTS ON THE SCYLLA IV THETA PINCH. Gribble, R. F.; Little, E. M.; Quinn, W. E. (Los Alamos Scientific Lab., N. Mex.). 6p.

Faraday rotation measurements have been combined with Mach–Zehnder interferometer measurements to yield the value of the internal magnetic field B_i in the Scylla IV plasma as a function of time and radius. Since the Faraday rotation is proportional to $\int B_i(l) n_e(l) dl$ and the Mach–Zehnder interferometer provides $\int n_e(l)\, dl$, the data yield the average value of the internal magnetic field $B_i(r)$ which exists over the plasma length l at the radius r. The measurements of B_i (r) are combined with those of the external magnetic field B_e to determine the average plasma β as a function of radius, $\beta = 1 - B_i^2(r)/B_e^2$. The Faraday rotation measurement employs a 1.5-mm–diameter beam of visible radiation (6328 Å) from a He–Ne gas laser as a plasma magnetic-field probe and a calcite Wollaston prism as the polarization analyzer with silicon diode detectors. In the low-pressure plasma regime (10 to 25 mtorr) the β values in the central plasma core (~5-mm diameter range between 0.9 and 1.0 with initial reversed bias magnetic fields and values between 0.7 and .95 without bias fields. Radial profiles of β averaged over the plasma length have been obtained at various times during the discharge. A combination of β, n_e and T_e in the simple pressure balance yields ion temperature in the 2- to 10-keV region. (auth)

1156 (LA–3770, Paper D2) SPACE–TIME RESOLVED MACH-ZEHNDER INTERFEROMETER MEASUREMENTS OF CROSS-SECTIONAL ELECTRON DISTRIBUTION IN THETA-PINCH PLASMA. Roberts, Howard N.; Weigl, Frederic; Dougal, Arwin A. (Texas Univ., Austin). 5p.

A 2 in.-ID quartz tube with quartz end windows is closely encircled by a 20-cm coil (1.15 mirror ratio) in a four-stage, 30-kJ θ pinch (3.0 μsec quarter period). A 175-MW giant pulse (15 nsec) ruby laser illuminates the interferometer. A distinct density minimum persists on the plasma axis as late as 3.2 μsec into the main compression for initial deuterium pressures of 0.05 to 0.1 torr, reverse bias fields of 2 to 6 kG, and peak fields of 17 to 60 kG. Measurable neutron emission consistently begins within 0.2 μsec of the time the density minimum vanishes (typically 1.2 to 1.6 μsec after main field initiation). Peak densities observed are 2 to 30×10^{16} cm^{-3}. Near 1.0 μsec after initiation of main compression 6 to 10 rotating flutes appear and remain until about 2.0 μsec. The e-folding times of plasma density are 2 to 12 μsec prior to peak compression and 0.4 to 3.0 μsec afterwards. These loss rates agree within 50% to predictions of free flow through an orifice the size of an ion Larmor orbit. Correlation to analytical predictions of electron distribution by a Hain–Roberts code in which the coordinates move with the current sheath is within 20%. (auth)

1157 (LA–3770, Paper E6) TRANSIENT SPECTRAL STUDY OF DISCHARGES IN COAXIAL PLASMA GUNS. Michels, Charles J.; Hettel, Henry J. (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). 5p.

Time-varying spectra of argon plasma in a coaxial plasma gun are measured for two geometries. One geometry, operating self-crowbarred, exhibits a fully ionized argon plasma (relatively "clean") for the first moving discharge in the gun. Performance agrees well with earlier snowplow model theory and experiment. In contrast, the other geometry which operated in the multiple moving puff mode, exhibits a contaminated discharge with no propellant lines observed. A pyrex gas baffle is the source of contaminants. Performance does not agree with theory. (auth)

1158 (LA–3770, Paper E7) INVESTIGATIONS OF A CESIUM PLASMA ACCELERATOR WITH OPTICAL DIAGNOSTICS IN THE VISIBLE AND VACUUM ULTRAVIOLET. Simon, D. R.; Hill, D. A.; Levy, M. E. (Vitro Labs., West Orange, N. J.). 7p.

The cesium plasma generated by a low-inductance coaxial accelerator has been previously investigated using electrical probes. Time-of-flight measurements with these probes indicated plasma velocities of 3×10^8 cm/sec. In order to confirm the existence of the fast plasma front and establish the constituents of it, a series of spectroscopic experiments has been conducted in the visible and vacuum ultraviolet. A high-dispersion spectrum of the discharge was obtained to identify the species present. Photoelectric detection was used to observe the radiation from the leading and trailing plasma fronts with submicrosecond time resolution. In order to estimate the density of the cesium in the plasma, records of the 926-Å ground-state transition of the cesium ion were obtained in the vacuum ultraviolet with a Seya-type 0.5-meter monochromator equipped with a 1200 line/mm platinum-coated grating blazed for 700 Å. The total number of cesium ions in the 10^8 cm/sec velocity range is shown to be 10^{13} to 10^{14} per pulse. The analysis of the 926-Å data coupled with the supporting data in the visible and quartz ultraviolet indicates that the ejected plasma consists of a fast leading edge of cesium ions with an average velocity of 2.5×10^8 cm/sec and a slow trailing region of cesium and electrode material such as tungsten and thoria. Hydrogen was not detected at any time as an impurity in the measurements, indicating that Ly-β radiation did not enhance the cesium ion ground-state radiation. (auth)

1159 (LA–3770, Paper E9) COMPARISON OF ION-PROBE AND DOUBLE-LANGMUIR-PROBE MEASUREMENTS ON PLASMA BLOBS. Fearn, D. G.; Wooding, E. R. (Royal Holloway Coll., Englefield Green (England). Dept. of Physics). 4p.

A comparison has been made of electron densities and temperatures determined from a Faraday-cup ion probe and a double Langmuir probe under conditions where the latter has been reported to give results consistent with spectroscopic measurements. Both probes were inserted into the plasma ejected at about 10^6 cm/sec from a conical z-pinch plasma gun. Saturation of the ion probe collector current occurred only with apertures less than about 0.025 cm in diameter or low-density plasmas. The double probe yielded $n_e = 1$ to 4×10^{15} cm^{-3} and $T_e = 1$ to 3×10^4°K, while values of n_e from the ion probe were lower by a factor 10, with T_e greater by a factor 3. Calorimeter measurements of the total plasma energy were consistent with the double-probe results, when an allowance was made for the presence of neutral particles. (auth)

1160 TEMPERATURE EFFECTS ON WHISTLER RESONANCE. Kent, Gordon (Syracuse Univ., N. Y.). J. Appl. Phys., 38: 4873-81(Nov. 1967).

The effects of longitudinal temperature on the index of refraction of the whistler mode are calculated. The theory involves an unusual assumption on the initial rf velocity, and as a consequence the problem is stated in terms of a singular integral equation. The integral equation is solved with no limitation on the analyticity of the distribution function. Numerical data are given showing the index of refraction as a function of magnetic field, with temperature as a parameter. The whistler resonance responses of two structures are presented, and a necessary condition for the observation of a whistler resonance in a one-dimensional warm plasma is derived. It is proposed that the whistler resonance could be used for plasma diagnostics in a discharge produced in a microwave cavity. (auth)

1161 TEMPERATURE DETERMINATION FROM THE INTENSITY RATIO I(TRIPLET)/I(SINGLET) OF TWO HeI LINES IN NONTHERMAL PLASMA. Drawin, H. W.; Henning, H. (EURATOM–CEA, Fontenay-aux-Roses, France). Z. Naturforsch., 22A: 587-8(1967). (In German).

The temperature determination from the intensity ratio I(triplet/I(singlet) of two He I lines in nonthermal plasma was critically analyzed. It is shown that the triplet to singlet intensity ratio is so dependent on processes which are connected with the two excited levels 4^3S and 4^1D levels that completely different results are obtained according to the approximation on these processes. The consideration of the collisions of excited levels with other plasma parts leads to intensity ratios which show a very low-temperature dependence. The solution of the balance equation system shows, on the contrary, that the intensity ratio depends much more strongly on pressure than on temperature. The method is therefore not suitable for the determination of the electron temperature in nonthermal laboratory plasmas. The temperature is obtained sufficiently accurately only when lines are selected whose energy levels are as far as possible from each other. (J.S.R.)

1162 CONDENSATION AND ELECTRICAL CONDUCTION IN METALLIC VAPORS. Solbes, Albert; Kerrebrock, Jack L. (Massachusetts Inst. of Tech., Cambridge). Phys. Fluids, 10: 2179-98(Oct. 1967).

A first-order theory of the bulk properties of condensing metallic plasmas is proposed. The theory accounts for the effects of ionization on the condensation process, and of the liquid phase on the electrical properties of the plasma. It indicates that there should be an increase in the effective supersaturation, due to impact of ions on droplets, if the electron density is high. It also predicts the existence of a critical electron temperature, such that for larger temperatures, a nonequilibrium state of high electron density can be maintained, while for lower temperatures the electron density approaches that in equilibrium with the droplet's surface. Experiments carried out in wet potassium vapor qualitatively confirm the existence of the critical temperature. The electrical conductivity of dry potassium plasma agrees quantitatively with that predicted by the two-temperature theory, with an electron collision cross section of 250 $Å^2$. (auth)

1163 ELECTRICAL CONDUCTIVITY OF A MULTI-ION SPECIES PLASMA. Dawson, J. M. (Princeton Univ., N. J.). Contract AT(30-1)-1238. Phys. Fluids, 10: 2280-1(Oct. 1967).

A small number of highly ionized impurities have a large effect on plasma conductivity. Temperatures computed from measured

conductivities may be in error unless these are properly taken into account. It is shown how this should be done. (auth)

1164 OPTICAL DETERMINATION OF BARIUM PLASMA DENSITY. Motz, Robin O. (Stevens Inst. of Tech., Hoboken, N. J.). Contract AT(30-1)-2813. Phys. Fluids, 10: 2282-3 (Oct. 1967). (SIT-2813-41).

It is shown theoretically that a measurement of just the scattering of resonance radiation from a barium plasma column can underestimate the total ion density by as much as 30%. (auth)

1165 COMPARISON OF LANGMUIR PROBE AND MICROWAVE DIAGNOSTIC TECHNIQUES. Graf, K. A.; de Leeuw, J. H. (Univ. of Toronto). J. Appl. Phys., 38: 4466-72(Oct. 1967).

Electron densities have been measured in the subsonic portion of a free-expansion argon jet by microwave and Langmuir-probe methods. Microwave phase-shift measurements were made with an interferometer in such a way that the spatial variation of electron density could be determined. The data were analyzed with a ray-tracing technique. Langmuir-probe measurements were made with cylindrical and flat probes under essentially collision-free conditions, and over a range of probe radius to Debye length ratios of about 10 to 50. Both electron and ion collections were measured and analyzed. Three methods of analyzing the electron-current part of the characteristic were compared. It was found that one method gave values two or three times higher than another method. The discrepancy was due to the failure of the experimental Langmuir-probe characteristic to follow the theoretical one in the vicinity of plasma potential: the so-called "knee" of the curve. This difficulty has been overcome by analyzing the data with the aid of theoretical particle-collection curves. (auth)

1166 SPURIOUS SECOND HARMONICS FROM MODULATED LANGMUIR PROBES. Olson, Robert A. (Systems Research Labs., Inc., Dayton, Ohio); Medicus, G. J. Appl. Phys., 38: 4539-40(Oct. 1967).

It has been shown that an alternating potential applied to a probe interacts with the plasma sheath surrounding the probe insulator to generate a second-harmonic current. This can cause considerable error in the measurement of the probe second-harmonic current in the far electron-repelling region of the probe curve where $J''(V)$ is small. Consequently, in the case of a large probe lead-plasma capacitance and relatively large alternating potential, it is necessary to eliminate or correct for the second-harmonic current through the probe insulator in order to obtain the true second derivative of the probe curve in the far electron-repelling region. (M.H.R.)

1167 EXPERIMENTAL INVESTIGATION OF LANGMUIR PROBES. Clements, R. M.; Skarsgard, H. M. (Univ. of Saskatchewan, Saskatoon). Can. J. Phys., 45: 3199-3209(Oct. 1967).

Electron temperatures and densities measured in a weakly ionized helium afterglow with cylindrical double probes are compared with measurements obtained using a gated microwave radiometer and a microwave resonant cavity. The pressure was varied from 0.1 to 8.5 torr. At low pressure, magnetic fields up to 0.11 T were applied. Independent of the values of the electron Larmor radii or particle mean free paths relative to the probe radius, the probes correctly measured the electron temperatures within an estimated random probable error of ±4% and a systematic error not exceeding ±4%. This demonstrates the validity, for the range of conditions studied, of a fundamental assumption of probe theory—that electrons in a retarding probe field are in a Maxwell–Boltzmann distribution at a temperature unaffected by the presence of the probe. Towards higher pressure the measurements show an increasing depression of the plasma density near the probe, associated with the diffusion to it. The applied magnetic field had no noticeable effect on the densities measured with the probes as compared with the cavity measurements. (auth)

1168 STARK BROADENING OF HYDROGEN LINES. Kurochka, L. N. (Kiev State Univ.). Sov. Astron. AJ (Engl. Transl.), 11: 290-6(Sept.-Oct. 1967).

Translated from Astron. Zh., 44: 368-76(Mar.-Apr. 1967).

A new relation between electron concentration n_e and the number of the last resolvable Balmer line is derived from the modern theory of line broadening in a plasma. The values of n_e are found to be 3 to 10 times smaller than those given by the Inglis–Teller formula. Another relation is obtained, yielding n_e as a function of the halfwidth of any Balmer line. Curves for the variation of Balmer-line halfwidth with line number are presented for n_e from 10^{16} to 5×10^{13} cm^{-3}. (auth)

1169 NEUTRON REACTIONS AS A MEANS FOR PLASMA DIAGNOSTICS. Lehner, G.; Pohl, F. (Institut fuer Plasmaphysik, Garching, Ger.). Z. Phys., 207: 83-104(1967). (In German).

The neutrons from d–d reactions in a hot deuterium plasma can be used for plasma diagnostic purposes. The ion velocity distribution is responsible both for the total rate of neutron production and the energy spectrum of the neutrons. Anisotropic velocity distributions give rise to neutron fluxes and neutron energy spectra which are also anisotropic. These effects are discussed for generalized Maxwellian distributions (characterized by different parallel and perpendicular "temperatures") and for monoenergetic distributions (three-dimensional and two-dimensional), which serve as typical examples. (auth)

1170 DETERMINATION OF THE PLASMA PARAMETERS FROM MEASUREMENTS OF THE REFLECTION COEFFICIENT IN A WAVEGUIDE. Zakrzewski, Zenon (Inst. of Fluid Flow Machinery, Danzig). Rozpr. Elektrotech., 13: 403-21(1967). (In Polish).

The theoretical fundamentals and descriptions are presented of a microwave method for plasma diagnostics. The proposed method can be applied to the determination of the electron density and collision frequency in a plasma column of small diameter. The description of the electromagnetic properties of plasma has been based on the elementary Lorentz theory and the assumption has been made of the plasma being a linear and isotropic medium. With such a plasma placed in a waveguide, the analytical dependence of the complex reflection coefficient on the plasma parameters was examined. Then the numerical calculations were made with the use of an electronic computer. The results of these calculations have been plotted in a special diagram, allowing the direct determination of the plasma parameters with a reflection coefficient known from measurements. The possibilities of elimination of an influence of a dielectric plasma container of the results of measurements have been considered. Finally, the measurements of electron density and collision frequency in the positive column of a glow discharge in argon are described. They were made in the microwave S band. The proposed method can be employed for plasma of electron densities exceeding those measurable by the conventional resonator methods. (auth)

1171 DEVELOPMENT STUDIES IN PLASMA DIAGNOSTICS AT THE GENERAL IONIC SERVICE IN 1966. Bull. Inform. Sci. Tech. (Paris), No. 116, 67-128(June 1967). (In French).

The devices and techniques developed for plasma diagnostics during 1966 are reported. The developments can be classified into four large subdivisions: devices using electrodes electrically polarized by static electric fields or hf fields, devices using the technique of coherent optics, devices based on fast electrooptics, and milametric hypofrequency devices. The devices described are: a device for the determination of the distribution function of electrons beginning with the separation of the probe current into its electron and electron components. Determination of the velocity distribution function beginning with the second derivative of the probe current, the electrostatic analyzer in continuous and pulsed regime, the electrostatic analyzer for the determination of ion energy, development of resonance probes, experimental verification of the operation of a polarized pyrometric probe, a holographic device, measurement of magnetic fields by the Faraday effect, recording of weakly luminous transitory phenomena using light amplifiers and the Stark and Zeeman effect, measurement of very low density plasma with a Fabry–Perot interferometer with focusing optics on the wave length 2.2 mm and interferential radiometer for the study of the diffusion of electromagnetic waves by ionized media. (J.S.R.)

Kinetics of Plasma

Refer also to abstracts 897, 1130, 1272, and 1370.

1172 (AD-646672) ELECTRICAL CONDUCTIVITY OF A PLASMA. Final Technical Report, October 1, 1963–September 30, 1966. Maeder, P. F. (Brown Univ., Providence, R. I. Div. of Engineering). Nov. 30, 1966. Contract AF49(638)-1295. 8p. (AFOSR-67-0306). CFSTI.

Both equilibrium and nonequilibrium plasmas in the presence of externally applied magnetic or electric fields were studied. The experimental techniques employed were primarily those developed previously for work with high-temperature gases, but extended to accommodate the nonequilibrium plasma tests and improved to permit measuring shock speeds in gases other than air. (auth)

1173 (AD-647683) THEORY OF NONLINEAR MIXED FREQUENCY GENERATION IN AN ANISOTROPIC PLASMA. Hagenbuch, K. M. (Pennsylvania State Univ., University Park. Ionosphere Research Lab.). Jan. 10, 1967. Contract AF19-(628)-4014. 75p. (AFCRL-67-0087). CFSTI.

The Maxwell equations and the fluid equations for a plasma are expanded in a perturbation series to investigate nonlinear mixed-frequency generation in a gyromagnetic medium. Neutral particles and ions are assumed to be fixed, collisions are neglected, and the Debye length is assumed to be small compared with the wavelengths of propagating radio waves. Using Fourier transforms, the second-

order amplitudes are found and the mixed frequency energy per unit area generated by two monochromatic waves in a homogeneous slab of thickness Δz during the time interval Δt are calculated. This result is applied to the case when the interacting waves are not monochromatic and when the plasma is slightly inhomogeneous. (auth) (TAB)

1174 (AD-648083) PLASMA STREAMING INTO A MAGNETIC FIELD. Ossakow, Sidney L. (California Univ., Los Angeles. Plasma Physics Group). Nov. 1966. Contract Nonr-4756(01). 65p. (R-10). CFSTI.

The following subjects are described: nonlinear solution for upper hybrid oscillations in a slab geometry; investigation of instabilities in the slab geometry; and the quasilinear boundary value problem. (auth) (TAB)

1175 (IPP-1/65) UNTERSUCHUNG AN EINEM THETA-PINCH PLASMA IM BEREICH DER PLASMAFREQUENZ. (Investigation on a Thetatron Plasma Near the Plasma Frequency). Gross, D. (Institut fuer Plasmaphysik, G.m.b.H., Garching (West Germany)). June 1967. 52p. (In German). Dep.

This investigation discusses to what extent the theory of radiation emission near the plasma frequency agrees with time-and space-resolved infrared emission intensities of a thetatron plasma. A new type of infrared optical system allowing radial resolution of the plasma radiation was designed for this purpose. A frequency band around 2.5 THz was filtered out and recorded with a helium-cooled, impurity-activated photodetector with a time resolution of 80 nsec. The radiation intensities of a dense thetatron plasma were recorded and compared with the results of a computer program. This program based on an experimentally verified hydromagnetic model of the thetatron plasma gives the time-dependent bremsstrahlung intensity in a ray optical approximation; supplementary computations have been carried out in wave optical approximations. The results of both calculations are in quantitative agreement with the infrared measurements except for a short radiation peak during the shock wave phase of the discharge. This peak can be interpreted, however, by means of a semi-quantitative evaluation as a microinstability-induced radiation burst originating from the outside surface of the compression shock wave. (auth)

1176 (IPP-1/67) UNTERSUCHUNGEN ZUR ANISOTROPIE UND RELAXATION DES PLASMAS AM ISAR I-MEGAJOULE-THETAPINCH. (Investigation on the Anisotropy and Relaxation of the Plasma in the ISAR I-Megajoule Theta Pinch). Andelfinger, C.; Fuenfer, E.; Lehner, G.; Paretzke, H.; Pohl, F.; Seidel, U.; Sommer, H. J.; Ulrich, M. (Institut fuer Plasmaphysik, G.m.b.H., Garching (West Germany)). Aug. 1967. 53p. (In German). Dep.

Due to the fast radial theta pinch compression one expects a strongly anisotropic ion velocity distribution. Theoretical considerations based on the Fokker-Planck equation taking into account both ion-ion and ion-electron collisions and their influence on the relaxation of the ion anisotropy are presented (G. Lehner, Z. Physik, in press). Theory shows that for an anisotropic plasma the neutron flux and energy spectrum from D-D reactions is also anisotropic. These predictions are compared with recent measurements on the Isar-I megajoule theta pinch. The measurements concern the anisotropy and axial distribution of the neutrons. Particle densities and end losses were studied by interferometric means. These measurements yield the perpendicular and parallel temperatures and the particle densities as functions of time. The maximum perpendicular ion temperatures are about 5 keV. The parallel ion temperatures taken from the rate of end losses are small in the beginning and increase quite fast after about a quartercycle. Detailed computations on the relaxation using the above-mentioned theoretical results are in very good agreement with the observations. (auth)

1177 (IPP-3/54) NONLINEAR INTERACTION BETWEEN ELECTROACOUSTIC AND TEM WAVES AT MICROWAVE FREQUENCIES. O'Brien, B. B. Jr. (Institut fuer Plasmaphysik, G.m.b.H., Garching (West Germany)). June 1967. 19p. Dep.

Measurements of mixing (nonlinear interaction) of two low-level microwave signals in an isotropic positive column are described. One signal (650 MHz) excites a propagating electroacoustic wave. The other signal (1150 MHz) propagating along a "TEM" line interacts with the plasma wave whereby signals with the sum and difference frequencies are produced (and observed). The amplitudes of the scattered signals are in reasonable agreement with the values predicted by a simple theory involving an "equivalent" dielectric constant $(\epsilon(\vec{r},t))$. (auth)

1178 (IPP-6/60) ZYKLOTRONWELLEN IM HEISSEN, ZYLINDRISCHEN PLASMA MIT INHOMOGENEM MAGNETFELD. (Cyclotron Waves in a Hot, Cylindrical Plasma with an Inhomogeneous Magnetic Field). Grawe, H. (Institut fuer Plasmaphysik, G.m.b.H., Garching (West Germany)). July 1967. 81p. (In German). Dep.

A method of calculating the propagation of rotational symmetric waves in a hot, circularly cylindrical plasma with a weakly inhomogeneous magnetic field is described. The frequency ω of the waves is not subject to any essential restrictions. Cyclotron waves, in particular, are thus taken into account as well. Attention in experiments is concentrated on rotational symmetric waves. In addition, it is shown that there is a simple theoretical reason for this restriction to the rotational symmetric case. From a model given by Stix for the cyclotron damping, one is first led to believe that the damping depends essentially on the strength of the inhomogeneity. This problem is discussed and it is shown that in a weakly inhomogeneous magnetic field the cyclotron damping is independent of the strength of the inhomogeneity. It is therefore possible to replace the weakly inhomogeneous magnetic field in the usual way with a partially homogeneous field. The Vlasov equation is taken as a basis to calculate the dielectric tensor and the pressure tensor for rotational symmetric waves in a homogeneous plasma with a homogeneous magnetic field. The components of the tensors can be expanded in powers of the gyroradii. Known boundary conditions at a circularly cylindrical plasma-vacuum interface are used. These govern the wave field in lowest order in the gyroradii. The dispersion relation thus obtained is the condition for the vanishing of a 5×5 determinant. In general, it can only be solved numerically. Restrictions on the frequency are subsequently introduced in order to reproduce known results. (auth)

1179 (LA-3770, Paper A1) SURVEY OF THE LINEAR THETA PINCH WORK IN GARCHING. Fuenfer, E. (Institut fuer Plasmaphysik, G.m.b.H., Garching (West Germany)). 8p.

The main objectives are very hot, high β-plasmas, collisionless compression and turbulent heating, and M&S experiments. Low filling densities down to 10^{13} cm^{-3} are required and preionization becomes a severe problem. Therefore three different methods were investigated: the high frequency theta pinch with dynamically confined plasma, the high-voltage z pinch with short current pulse and the photoionization by strong ultraviolet radiation. In the main discharge highly anisotropic plasmas with ion temperatures of several keV can be observed. The time behavior of the anisotropy is compared with theoretical considerations. Electron temperatures of some 100 eV were found by laser scattering experiments. The values from x-ray absorption were much higher and not reproducible. Coherent laser scattering at 90° with a theta pinch of high density and low temperature allowed the measurement of spectrally resolved ion and satellite lines. The influence of mirrors on end losses and stability has been studied. The plasma remains stable in the low pressure regime for a low impurity level. Two-dimensional programs are treated: a (r,z) program for end losses and thermal conductivity and a (r,φ) program for plasma rotation. A programme for collisionless compression with a phenomenological friction term was also treated. A preliminary linear M&S experiment (Limpus) on Isar I showed no noticeable difference in its behavior as compared with a straight coil. (auth)

1180 (LA-3770, Paper A2) OBSERVATIONS IN AN 8-METER THETA PINCH. Bodin, H. A. B.; Newton, A. A. (United Kingdom Atomic Energy Authority, Abingdon (England). Culham Lab.). 6p.

Experiments using a coil 8-m in length and 11 cm in diameter are described. The magnetic field reaches 25 kG at 40 kV and decays when crowbarred with at time constant of 160 μsec. The plasma temperature is ~100 eV and density $\sim 3 \times 10^{16}$ cm^{-3} on axis. The plasma in the midplane is unaffected by the ends for long relative times. The plasma remains close to the tube axis along its length for some tens of μsecs, showing only slight transverse motion. An axisymmetric magnetic field perturbation was produced in the midplane after the implosion, and the observed growth and propagation of the m = 1 instability agreed with ideal hydromagnetic theory. Higher modes were not observed. It was shown by analyzing the radial density distribution that the diffusion rate was least when the discharge was quiescent; much faster diffusion rates were observed when there were radial accelerations due to the implosion, oscillations, or rotation. (auth)

1181 (LA-3770, Paper A4) STUDY OF TRAPPED REVERSE FIELD CONFIGURATIONS IN A LINEAR THETA PINCH EXPERIMENT. Kaleck, A.; Kever, H.; Koenen, L.; Noll, P.; Sugita, K.; Waelbroeck, F.; Witulski, H. (Kernforschungsanlage, Juelich (West Germany). Institut fuer Plasmaphysik). 7p.

At the 120-cm-long theta-pinch experiment (Julietta), the decay of closed-field configurations produced by compressing plasmas with reverse bias field and their axial evolution have been studied by simultaneous measurements of continuum radiation profiles at different axial positions and with a set of compensated loops. For

typical discharge conditions with reduced energy (50 mtorr D_2, 1.9 kG bias field, B_{max} = 35 kG, half period 11 μs, T_e = 250 eV, n_e = 5×10^{16} cm^{-3}), the antiparallel magnetic flux stays roughly constant during the adiabatic compression and decompression phases in agreement with numerical calculations. After a fast axial contraction, the length of the configuration remains approximately constant (≈⅔ of the coil length) and the axial homogeneity is fair. For other initial conditions (larger D_2 pressure and/or with weaker pre-ionization) strong axial inhomogeneities of the plasma diameter and of the diamagnetism are observed which can result from end effects (axial waves), from field inhomogeneities of the observation windows, or from inherent instabilities. When the condenser bank energy is increased to 600 kJ, axial variations are more pronounced and plasma rotations are detected after the peak compression. (auth)

1182 (LA-3770, Paper A8) THETA PINCH WITHOUT THE INTERACTION BETWEEN PLASMA AND NEUTRALS AT THE ENDS. Kawasaki, S.; Uchida, T. (Nagoya Univ. (Japan). Inst. of Plasma Physics). 5p.

A theta pinch system where there was no interaction between the plasma and the neutrals remaining at the ends of the coil, was realized in success, using the high speed gas injection system set in the middle of the coil. The typical character of the experiment is that the distribution of the gas is localized in a sufficiently long coil, so that one can get rid of the effect of the neutrals which would remain in the ordinary theta pinch. Helium plasma produced is compressed by a magnetic field with a peak value of 23 kG. The single turn coil used here is 80 cm long and 10 cm in diameter. The plasma produced in the coil is about 60 cm long and seems relatively stable except a slight lateral drift to the wall, which might be due to the effect of the gas injector. The results of the preliminary experiments are given. (auth)

1183 (LA-3770, Paper B3) LONGITUDINAL FINITE AMPLITUDE WAVES IN A COLLISIONAL PLASMA. Kever, H. (Kernforschungsanlage, Juelich (West Germany). Institut fuer Plasmaphysik). 5p.

Steady nonlinear waves of finite amplitude which propagate along a constant magnetic field in an initially cold and uniform plasma are considered under conditions where collisions, either binary or collective, between ions and electrons cannot be neglected. In the present analysis, the assumption of negligible plasma pressure has been retained, the effect of collisions is taken into account through a collisional term which is proportional to the drift velocity between the ions and electrons. The structure of these waves has been investigated under the assumption that the collisional term is small, and an asymptotic solution has been obtained of first order in the ratio of the effective collision frequency and the cyclotron frequency of the electrons in the unperturbed magnetic field. From this solution the scaling lengths within the wave, the angle of rotation of the magnetic field and the amount of heating are inferred. (auth)

1184 (LA-3770, Paper B6) CONTINUUM EQUATIONS FOR FINITE BETA PLASMA SYSTEMS. Auer, P. L.; Kinsinger, R. E. (Cornell Univ., Ithaca, N. Y.). 4p.

A method of expansion has been developed earlier by one of us for solving the Vlasov equation. This method resembles CGL but takes into special account the effect of electric fields produced by space charge separation. We consider a plane disturbance propagating perpendicular to an axial magnetic field. In this case our method leads to a renormalized precession frequency and particle orbits which are distorted from circular into elliptical shape. The expansion is carried out to second order in the smallness parameter and a closed set is obtained which differs in certain respects from results of conventional CGL approach as well as from FLR results. The reason will be discussed in some detail. A single fluid formulation is obtained and examined with a view to understanding the role of finite beta in dynamic situations which produce strong gradients in the magnetic field and in the plasma properties. (auth)

1185 (LA-3770, Paper C5) FORMATION AND BREAKUP OF THE PINCH IN PLASMA FOCUS. Long, J. W.; Peacock, N. J.; Wilcock, P. D. (United Kingdom Atomic Energy Authority, Abingdon (England). Culham Lab.); Speer, R. J. (Imperial Coll. of Science and Tech., London (England)). 6p.

A superdense pinch is generated in an open-ended, metal-walled tube between coaxial electrons. The collapse of the current sheath at the open end of the electrodes and the formation and breakup of the focus is studied using an image-converter camera with a 10-nsec exposure, x-ray pinhole photography and grazing-incidence spectroscopy. The current sheath collapses radially to a narrow filament, 0.5 mm in diameter, in less than 10^{-7} sec. Due to the initial forward momentum the filament rapidly elongates, travelling 2 or 3 cm axially in 2×10^{-7} sec. Instabilities of the m = 0 type with growth times less than 0.5×10^{-7} sec break up the plasma locally. The filament is sustained, however, by further compressions and the total "sustainment time" can last up to 3×10^{-7} sec., i.e., the duration of the thermal x-ray and neutron emission. The plasma has an electron temperature of several keV and a density greater than 10^{19} cm^{-3}. The addition of a few percent heavy gas prolongs the lifetime of the filament and markedly increases the x-ray emission. Resonance lines and free-bound recombination continue at wavelengths <10Å in H- and He-like ions of these added gases confirm a relatively high electron temperature in the pinch. (auth)

1186 (LA-3770, Paper C7) COAXIAL SNOWPLOW DISCHARGE. Butler, T. D.; Henins, I.; Marshall, J.; Morse, R. (Los Alamos Scientific Lab., N. Mex.). 4p.

A coaxial-type discharge system has been operated without an outer electrode and with static fillings of several different gases over wide ranges of filling densities. Plasma light photographs and magnetic probe analysis show a sharply defined current and plasma layer for most operating conditions. A cylindrical snowplow model for the plasma layer gives reasonable quantitative agreement with all phases of the discharge including the period during which the plasma layer leaves the end of the center electrode and forms a pinch on the center axis of the system. Experimental and theoretical numerical results are shown. (auth)

1187 (LA-3770, Paper D5) BREMSSTRAHLUNG OF DENSE HOT PLASMA IN THE WAVELENGTH RANGE 0.25 TO 25 μ. Bogen, P.; Dippel, K. H.; Rusbueldt, D. (Kernforschungsanlage, Juelich, Juelich (West Germany). Institut fuer Plasmaphysik). 5p.

Experiments have been carried out on a theta pinch (T/4 = 0.75 μsec, B_{max} = 45 kG) in order to compare the absolute intensity of the bremsstrahlung as well as its wavelength dependence with the theoretically expected values. Side-on interferometric measurements (Mach-Zehnder interferometer and Abel inversion) yielded the radial density distributions. These, together with measured electron temperatures, lead to a "theoretically" expected intensity. Quantitative agreement with observed values in the visible spectrum was found, when $T_e \leq 10^{6.6}$K and $N_e \leq 3 \times 10^{17}$ cm^{-3}. The observed values are significantly larger when $T_e > 10^{6.6}$K and smaller when $T_e < 10^{6.6}$K and $N_e > 3 \times 10^{17}$ cm^{-3}. The wavelength dependence of the intensity between 0.25 and 25 μ has been measured with a time resolution of 20 nsec using an InAs photodiode and a copper-doped germanium photoresistive detector in the infrared, and a photomultiplier in the visible and ultraviolet domains. Side-on, the emission signals were at all times and for all wavelengths proportional to one another, whereas end-on some shape differences were observed, presumably, because of refractive index effects. The experiments confirm the theoretical prediction, that the Gaunt factor should vary by a factor two in the investigated wavelength domain. (auth)

1188 (LA-3770, Paper D6) DIRECT MEASUREMENT OF MASS PICKUP IN A LOW-ENERGY THETA PINCH. Harris, Robert W. (Sandia Corp., Albuquerque, N. Mex.). 5p.

A balanced magnetic probe technique has been used to determine the drive force acting on the plasma sheath during the first pinch. The sheath motion was studied with the probe technique, and with image converter framing pictures. The sheath mass was determined from the velocity and the time integral of the drive force. The results indicate an average pickup coefficient of 0.82 ± 0.06 for the first half of the pinch. Electron density and temperature were determined during the first half of the pinch by measurement of the H_β line profile. Combination of the spectroscopic and mass data indicates an average sheath ionization lower than predicted by theory, but the experimental error in the ionization determination precludes a definite conclusion to this effect. (auth)

1189 (LA-3770, Paper E3) PROPERTIES OF THE SPOKES IN COAXIAL AND PARALLEL-PLATE PLASMA ACCELERATORS. Prior, W.; Bostick, W. H.; Grunberger, L.; Palmadesso, P.; Zorskie, J. (Stevens Inst. of Tech., Hoboken, N. J.). 4p.

Image converter photographs have shown that the "spokes" produced in the plasma coaxial accelerator at 2-mm hydrogen pressure are produced in pairs. Magnetic probe measurements indicate that the spokes have roughly the magnetic structure of a quasi-force-free configuration. Although the structures are too small in diameter (1 mm) to make ion-density-flow probe measurements of their profiles, there are compelling reasons to predict that these structures have mass flow patterns which are roughly parallel to the quasi-force-free magnetic structure. Schlieren and spectroscopic techniques for measuring ion density profiles of the vortices will be described. Spectroscopic techniques for measuring rotational velocity profiles will also be described. Theoretical attempts to understand these structures as minimum energy configurations will be set forth. (auth)

1190 (LA–3770, Paper E4) DEPOLARIZING CURRENTS IN A DENSE PLASMA INJECTED ALONG A DOUBLE BEND MAGNETIC FIELD. Veron, D. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). 6p.

A coaxial gun with an inverse pinch like preionization system and an axial magnetic field produces a dense, high-velocity plasma. By varying the parameters of the gun, the fast component mean velocity can be set from 10^8 to 2×10^8 cm/sec and the density from 0.4 to 3×10^{13} ions cm^{-3}. The plasma is injected parallel to the axis of a metallic tube having two identical oppositely curved sections, each extending over $\frac{1}{8}$ of circumference. The radius of curvature is 1 m, and the diameter of the tube is 30 cm. The longitudinal guiding field is 3 kG in most of the experiments. The electric drift of the plasma can be strongly reduced by increasing the transverse conductivity between the gun and the first curvature. In such conditions, the circulation of electron currents along the field lines has been evidenced. The depolarizing circuits of the plasma have been determined as a function of time. At first, the electrons flow towards the gun. Then, when the ion drift currents of each bend region are equal (with reversed signs), the current circulating towards the gun vanishes, and, as expected, a self-depolarization of the whole plasma is obtained by an electron flow between the two oppositely curved regions. The magnitude of the measured electron currents agrees with the ion drift current calculated from the plasma profile density at a given time. (auth)

1191 (LA–3770, Paper E8) EXPERIMENTAL INVESTIGATIONS OF NORMAL IONIZING SHOCK WAVES. Levine, Leslie S.; Gross, Robert A. (Columbia Univ., New York). 6p.

Experiments were conducted on normal ionizing shock waves produced in a coaxial electromagnetic shock tube. Steady shock velocities were measured as a function of initial gas pressure, drive current, and applied axial magnetic field. The speeds agreed well with theoretical values. Shocks propagating at trans-Alfvénic speeds ($u_{Alf_1} \leq u_s \leq 3u_{Alf_1}$) were studied. Measurements were made of the upstream transverse electric field and the switch-on magnetic field. Their magnitudes were in good agreement with the predictions of the Chapman–Jouguet hypothesis. Further support for this theory was provided by the measured compression ratio across the shock front. It was concluded that trans-Alfvénic normal ionizing shocks exhibited Chapman–Jouguet behavior with current flow in the shock front, and no separation of shock and drive currents. In contrast, super-Alfvénic shocks ($u_s \geq 3u_{Alf_1}$) appear to be gas dynamic in nature. Spectroscopic measurements and shock-reflection studies demonstrated the presence of a nonluminous front and shock-heated gas preceding the drive current in this regime. The luminosity front acts as a contact surface separating the unequilibrated shock from the luminous current. Finite transverse electric fields have been observed at super-Alfvénic shock speeds. This effect was attributed to the finite conductivity of the plasma. (auth)

1192 (LA–3770, Paper F1) NUMERICAL CALCULATIONS IN MAGNETOHYDRODYNAMICS. Hain, Klaus (Naval Research Lab., Washington, D. C.). 9p.

Numerical solutions for one-dimensional time-dependent problems in magnetohydrodynamics are widely used for the interpretation and planning of experiments. Since the extension of these calculations to more dimensions is now feasible, it is appropriate to summarize the basic assumptions and numerical methods for the solution of one-dimensional fluid dynamic problems. Computing schemes for two-dimensional magnetohydrodynamics are discussed. A simple implicit difference scheme is developed. The boundary conditions are treated by means of Green's functions. (auth)

1193 (LA–3770, Paper F2) COMPUTER SIMULATION OF THE THETA PINCH. Oliphant, Thomas A. Jr. (Los Alamos Scientific Lab., N. Mex.). 3p.

A preliminary calculation of the dynamics of the theta pinch during its initial compression was discussed in a previous paper. The calculation represented a feasibility study of the methods used. This calculation was refined by including Joule heating, electron heat flow, and electron–ion temperature equipartitioning. This allows one also to include a realistic estimate of the ion–ion collision frequency. Thus, quantitative predictions were made with the present numerical program. In a preliminary calculation a z-dependence of the magnetic field was allowed in order to obtain a qualitative estimate of the effect of a mirror field on end losses. For the first quantitative problem the simpler case of a z-independent theta pinch without end losses was considered. The physical problem studied was the same Scylla-III experiment which was discussed in connection with a purely MHD calculation. While the overall result of the pinch compression is the same with this new approach, there are noticeable differences in detail, the most important of which is the structure of the shock front. In the present calculation the snowplow effect was much more realistically than it was seen in the MHD calculation. The calculation was followed through the first reflection of the shock wave from the center of the plasma. (auth)

1194 (LA–3770, Paper F4) VARIATIONAL APPROACH TO THE CLASSIFICATION OF NONLINEAR MAGNETOHYDRODYNAMIC WAVES AND PLASMOIDS. Wells, Daniel R. (Miami Univ., Coral Gables, Fla. Dept. of Physics); Norwood, Joseph Jr. (National Aeronautics and Space Administration, Langley Station, Va. Langley Research Center). 4p.

Variational methods are used to determine the structure of dynamically stable plasmoids. The total energy of the plasmoids is varied subject to a set of constraint integrals on the flow. It is demonstrated that the resulting flow structure is an azimuthally symmetric geometry results in a plasmoid of the type observed experimentally when the angular momentum of the plasmoid is not conserved. This is the colinear vortex structure. New experimental results are presented which clearly demonstrate that the structures observed in mirror trapping experiments are of the type predicted by the variational calculation. The colinear plasmoid structures are shown to be members of a class of nonlinear transverse waves that trap and transport fluid mass. It is also demonstrated that a modification of these solutions that assumes conservation of angular momentum of the plasmoid describes another type of vortex structure which is centered on the magnetic field lines and moves at right angles to the field. This is the H-centered vortex structure. It corresponds to the vacuum field limit of the classical weak magnetoacoustic wave solutions. (auth)

1195 (LA–3770, Paper G2) ANISOTROPY AND ITS RELAXATION IN A FAST MEGAJOULE THETA PINCH. Andelfinger, C.; Fuenfer, E.; Lehner, G.; Pohl, F.; Seidel, U.; Sommer, J.; Ulrich, M. (Institut fuer Plasmaphysik, G.m.b.H., Garching (West Germany)). 5p.

Due to the fast radial theta pinch compression one expects a strongly anisotropic ion velocity distribution. Theoretical considerations based on the Fokker–Planck equation taking into account both ion–ion and ion–electron collisions and their influence on the relaxation of the ion anisotropy are presented (G. Lehner, in press, Z. Physik). Theory shows that for an anisotropic plasma the neutron flux and energy spectrum from d–d reactions is anisotropic, too (G. Lehner, F. Pohl, in press, Z. Physik). These predictions are compared with recent measurements on the Isar-I megajoule theta pinch (C. Andelfinger et al., IPP Report 1/67 (1967)). The measurements concern the anisotropy and axial distribution of the neutrons. Particle densities and end losses were studied by interferometric means. These measurements yield the perpendicular and parallel temperatures and the particle densities as functions of time. The maximum perpendicular ion temperatures are about 5 keV. The parallel ion temperatures taken from the rate of end losses are small in the beginning and increase quite fast after about a quartercycle. Detailed computations on the relaxation using the above-mentioned theoretical results are in very good agreement with the observations. (auth)

1196 (SC-CR-67-2710) STUDIES OF MICROWAVE TRANSMISSION THROUGH A HYPERSONIC AIR PLASMA. Final Report, June 1967. Boyer, D. W.; Bein, G. P.; Andre, S. N. (Cornell Aeronautical Lab., Inc., Buffalo, N. Y.). Contract AT(29-1)-789. 115p. Dep. CFSTI.

For Sandia Corp., Albuquerque, N. Mex.

Analytical and experimental studies are described of microwave transmission through a hypervelocity plasma generated about a blunt 20° wedge from an open-ended waveguide on the wedge surface. The experiments comprised the measurement of signal attenuation at selected locations in the antenna/model far field, antenna reflection coefficient (magnitude only), and coupling between two adjacent antennas on the model at frequencies of 1.7, 2.6, and 4.0 GHz. (auth)

1197 (AD–653513) ACADEMY OF SCIENCES OF THE USSR. POWER ENGINEERING INSTITUTE. PHYSICAL GAS DYNAMICS, HEAT TRANSFER AND THERMODYNAMICS OF HIGH TEMPERATURE GASES (SELECTED ARTICLES). Translation of Fiz. Gazodinam. Svoistva Gaz. Vys. Temper., Akad. Nauk SSSR, Gos. Prizvod. Kom. Energ. Elekt. Energ. Inst., 29-33; 104-14(1964). 26p. (FTD-MT-65-552). CFSTI.

The concentration of free electrons and the number of collisions of electrons with molecules were calculated in the first paper in order to find the electrophysical parameters of plasma after a shock wave in air. The methodological questions of interferometric investigations in a shock tube created in the laboratory are described in the second paper. The interferometric method of investigation of high temperature gas flows permitted one to obtain a distribution of density in flows of constant composition. An interferometer of Mach–Zehnder type was used. Methods of photo-

graphic recording of interference patterns were described. Processing of interferograms was discussed. (auth)

1198 BEAM–PLASMA INTERACTION WITH TRANSVERSE MODULATION. Mills, D. M.; Abraham, E. E.; Crawford, F. W. (Stanford Univ., Calif.). J. Appl. Phys., 38: 4767-79(Nov. 1967).

Experimental observations of electron beam–plasma interaction in low-pressure mercury-vapor discharges are described. Comprehensive data have been obtained of rf growth, phase velocity, axial and radial electric field profiles in the interaction region, and Faraday rotation, for the case of transverse modulation, i.e., for growth in the first azimuthally-varying mode (m = 1). The work complements previous parallel studies of the axisymmetric mode (m = 0) made with axial modulation. The results are compared with cold- and warm-plasma theories of the interaction. It is concluded that the warm-plasma theory gives a satisfactory approximation to the experimental results, and that the remaining discrepancies are due to lack of sharpness of the experimental beam edge. (auth)

1199 WAVE PROPAGATION IN A WAVEGUIDE PARTIALLY FILLED WITH PLASMA IN AN INFINITE AXIAL MAGNETIC FIELD. Bevc, Vladislav (Aerospace Corp., El Segundo, Calif.). J. Appl. Phys., 38: 4857-66(Nov. 1967).

Electromagnetic-wave propagation for axisymmetric and dipolar modes in a circularly cylindrical waveguide containing a plasma column in an infinite axial magnetic field is studied. The plasma column is assumed to be cold, collisionless, and of uniform density, with a diameter one-half the diameter of the waveguide. Numerical solutions of the dispersion equation for typical cases at various values of the plasma density are presented. The electric field and power-flow density distribution are examined quantitatively for representative modes with reference to the existence of surface waves. It is shown that for an infinite magnetic field the high-frequency field distribution within the plasma can be a modified Bessel function of the first kind only for the superluminous phase velocities and only at plasma frequencies that exceed the lowest vacuum waveguide cutoff frequency. For slow waves of very short wavelength, $\omega/c \ll 2\pi/\lambda_z$, the electromagnetic field and the power-flow density distribution are found to be confined to the plasma column with practically no field existing in the vacuum between the plasma and the waveguide wall. (auth)

1200 PLASMA ACCELERATION WITH MICROWAVES NEAR CYCLOTRON RESONANCE. Kosmahl, H. G. (NASA, Lewis Research Center, Cleveland, Ohio); Miller, D. B.; Bethke, G. W. J. Appl. Phys., 38: 4576-82(Nov. 1967).

Acceleration of a microwave-energized plasma by expansion in a diverging magnetic field is studied. Results of a theoretical collisionless particle analysis are reviewed. An experimental accelerator is described and its pertinent conditions are considered. Measurements of plasma beam shape and potential are compared with the theoretical predictions. The conclusions are that, while some experimental characteristics (beam shape and potential profile) agree with theory, collisions in the experimental device prevent it from attaining operating conditions predicted by collisionless theory. (auth)

1201 WAVE EXCITATION IN COMPRESSIBLE PLASMA AND EQUIVALENCE RELATIONS. Wu, Yung-Kuang (Southeastern Technological Inst., North Dartmouth, Mass.). J. Appl. Phys., 38: 4678-88(Nov. 1967).

A general, unified solution of the wave excitation due to electric-current sources, magnetic-current sources, fluid-flux sources, and mechanical-body sources in a compressible plasma which may be anisotropic and inhomogeneous is presented. The Maxwell–Euler equations are reformulated through linear operator and generalized transform techniques into an equivalent matrix integral equation. The dispersion relation can be obtained from the kernel of the integral equation. When the medium is homogeneous, this integral equation has an ideal kernel and the explicit solution can be easily obtained. Equivalence relations between different types of sources are obtained from the forcing function of the integral equation, which can be employed to express the field excited by one type of source in terms of the field excited by another type of source. Generalized telegraphist's equations are also derived in due course. Some dispersion curves, and asymptotic solutions for the radiation field from a point current source oriented in the direction of a constant magnetic field, are presented in graphical form. A proper ionospheric plasma is assumed for this calculation, which combines some of the results obtained for anisotropic cold-plasma problems on the one hand and some of the results obtained for isotropic warm-plasma problems on the other hand. (auth)

1202 ELECTRON-ELECTRON BREMSSTRAHLUNG FROM A QUANTUM PLASMA (Z = 1). Maxon, M. Stephen; Corman, E. Gary (Univ. of California, Livermore). Contract W-7405-eng-48. Phys. Rev., 163: 156-63(Nov. 5, 1967). (UCRL-70534).

The nonrelativistic limit of the Born cross section for electron–electron bremsstrahlung is integrated over a Maxwell–Boltzmann electron distribution. Results for the spectrum are compared with the electron–ion (Z = 1) bremsstrahlung spectrum found in the literature. The long-wavelength limit is obtained and compared with recent classical calculations. Corrections to the spectrum for low temperatures and high frequencies are discussed. It is concluded that at electron temperatures $kT_e \geq 10$ keV, electron–electron bremsstrahlung should be included in calculations of the emission spectrum, especially in the short-wavelength region. (auth)

1203 KINETIC THEORY FOR THE INTERPRETATION OF MEASUREMENTS ON FLUCTUATIONS IN RADIATION DISTRIBUTIONS IN FINITE, INHOMOGENEOUS SYSTEMS. Gelinas, R. J. (Univ. of California, Livermore); Osborn, R. K. Contract W-7405-eng-48. Phys. Rev., 163: 163-74(Nov. 5, 1967). (UCRL-70209).

A kinetic (transport) theory is presented for the first- and second-order (and, if necessary, higher) statistical moments of the number densities of the various particles and/or photons that describe the observable fluctuations in the radiation distribution from an emitting system. This treatment is particularly suitable for the analysis of finite, inhomogeneous systems that may be composed of detectors located outside of a radiating source. Considerable emphasis is placed upon an appropriate theoretical description of the actual observables of given experimental situations. The quantum Liouville equation is used to generate the coupled set of transport equations, and basic criteria for the applicability of transport and wave theories are discussed. Quantum-statistical effects are also quite naturally accounted for in cases where they are relevant. It is seen that fluctuation measurements are useful for inferring information relevant to the dynamic interactions within a given system. Such measurements often enjoy the feature of being passive with respect to the interacting system of interest. To illustrate the use of this spatially dependent form of kinetic theory on a system emitting optical radiation, an example that interprets a fluctuation measurement on the radiation emergent from a finite nondispersive blackbody is considered. The problems of statistical coupling between the radiation field and detector atom distributions are discussed. (auth)

1204 PARTITION OF RECOMBINATION ENERGY IN THE DECAYING RARE-GAS PLASMAS. Chen, Che Jen (Jet Propulsion Lab., Pasadena, Calif.). Contract NAS 7-100. Phys. Rev., 163: 1-7(Nov. 5, 1967).

In the collisional-radiative electron-ion recombination regime, the energy liberated from each recombination is partly carried away by a third colliding free electron and partly transformed into radiation. The partition of the energy among the electrons and radiation is obtained by comparing the probability of electron collisional de-excitation at different atomic-energy states, calculated by using Gryziński's formulation, and the spontaneous transition probability of bound electrons to all lower states evaluated by using the sum rule of line strength and the central-field approximation. A recombination-dominated decaying plasma is produced by a discharge tube energized with a capacitor bank. After cessation of the discharge current, the electron density, electron temperature, and atom temperature are measured by using both microwave and electrostatic probes, the spectral-line ratio method, and a fast-rise-time resistance thermometer, respectively. The partition of the recombination energy under different conditions for He, Ne, Ar, Kr, and Xe gases is determined from a solution of the electron-energy equation. The experimental results are in good agreement with the theoretical predictions. The oscillator strengths of the resonance lines for the five rare gases are also presented. (auth)

1205 IONIZED GASES IN THERMAL EQUILIBRIUM. Grandy, W. T. Jr. (Univ. of Wyoming, Laramie. Univ., Sao Paulo). An. Acad. Brasil. Cienc., 39: 65-87(Mar. 1967).

This paper is a survey of the theory of ionized gases in thermal equilibrium and, besides reviewing the thermodynamic properties in the different regions of the temperature–density spectrum, examines the recent work regarding the gas in a uniform magnetic field, the distribution functions of the system, the relativistic ionized gas, and the problem of single-particle bound-state contributions to the thermodynamic functions. In addition, several new results are presented regarding the fully ionized gas at high temperatures and low densities. 121 references. (auth)

1206 SIMPLIFIED EXPRESSIONS FOR THE TRANSPORT PROPERTIES OF IONIZED MONATOMIC GASES. Devoto, R. S. (Stanford Univ., Calif.). Phys. Fluids, 10: 2105-12(Oct. 1967).

Simplified theoretical expressions for the transport properties of ionized gas mixtures are derived within the framework of the Chapman–Enskog–Burnett method. The properties of equilibrium partially ionized argon are then computed with these expressions

and compared with values obtained with the exact theory. Agreement is satisfactory. (auth)

1207 BOLTZMANN EQUATION WITH CUTOFF POTENTIALS. Cercignani, Carlo (Massachusetts Inst. of Tech., Cambridge). Phys. Fluids, 10: 2097-2104(Oct. 1967).

After showing that the existence of a cutoff in the two-body interaction follows from consistency in the frame of assumptions upon which the Boltzmann equation is based, the collision operators for such cutoff potentials are studied in detail. It is proved that the essential properties required to build up a rigorous mathematical theory of the linearized Boltzmann equation are possessed by the collision with cutoff potentials. In particular, results of basic importance for existence, uniqueness, and approach to equilibrium are proved. (auth)

1208 ELECTRICAL CONDUCTIVITY OF SHOCK-HEATED AIR AND AIR-PLUS-TEFLON MIXTURES. Morsell, A. L. (Heliodyne Corp., Van Nuys, Calif.). Phys. Fluids, 10: 2171-8(Oct. 1967).

The electrical conductivities of shock heated air and air-plus-teflon mixtures have been measured using a method similar to the conducting gas-magnetic field interaction method described by Lin, Resler, and Kantrowitz. All measurements were made for an initial shock-tube pressure of 1 cm Hg. The air–Teflon mixture contained about 1 mole % of Teflon. The shock speeds ranged from 2.93 to 5.58 mm/μsec corresponding to temperatures between 3150 to 6500°K and conductivities between 0.24 and 111 mhos/m. The electron densities corresponding to these conductivity values range from less than 10^{11} electrons/cm^3 to about 10^{15} electrons/cm^2. No difference in conductivity between the air and air–Teflon mixtures was observed. Except for two conductivity values measured for very low shock speeds, all the measured values differ by less than a factor of 2 from theoretical values computed for pure air in equilibrium. (auth)

1209 CORRELATIONLESS PLASMA WITH TIME-DEPENDENT BACKGROUND STATE. Imre, Kaya (Conductron Corp., Ann Arbor, Mich.). Phys. Fluids, 10: 2226-34(Oct. 1967).

A Volterra-type (second kind) integral equation is derived for the electric charge density starting from the Vlasov equation linearized with respect to a time-dependent spatially uniform background state. The kernel of this integral equation vanishes identically in the case when the background state is time-independent (i.e., in the usual Landau problem), and the inhomogeneous term reduces to the exact solution of the initial value problem in the same case. It is shown that the inhomogeneous term of this integral equation corresponds to the adiabatic approximation; hence, a Neumann-series type solution can be constructed for the charge density by iteration of this inhomogeneous term for the case when the background state is varying slowly in time. Approximate solutions of this integral equation are obtained for the small time and asymptotic limits. It appears that for some particular cases it is possible to have nondecaying solutions for the continuum mode. This is in contrast with one of the basic assumptions of the quasi-linear theory of plasmas. (auth)

1210 SPACE-CHARGE EFFECTS BY NONTHERMAL IONS IN A MAGNETIZED PLASMA. Lehnert, B. (Royal Inst. of Tech., Stockholm). Phys. Fluids, 10: 2216-25(Oct. 1967).

In combination with transverse density gradients the finite Larmor radius produces space-charge effects both in the interior and at the boundaries of a magnetized plasma. In a thermal plasma having moderately large density gradients, electric quasi-neutrality can be preserved by a smoothly varying electric potential of limited amplitude. It is not obvious that a plasma containing groups of nonthermal ions will behave in a similar way when there are steep density gradients. An example is given here where a strongly oscillating potential of sheath-like structure arises from nonthermal ions which are peaked at a singular velocity. Whenever nonthermal effects of this or a similar kind occur, they should introduce fundamental changes in the plasma behavior which cannot be described by elementary plasma theory. Possible applications are given by the motion of a plasma through a neutral gas, where groups of nonthermal ions arise from charge exchange and ionizing collisions. The electric fields generated by the nonthermal particles may affect the ionization process and become connected with the mechanisms of ionizing waves and with the observed voltage limitation in rotating plasmas and in certain types of plasma guns. (auth)

1211 NONLINEAR PROCESSES IN A MAGNETIZED PLASMA. Cano, R.; Etievant, C.; Fidone, I.; Olivain, J.; Mattioli, M.; Perulli, M. (EURATOM–CEA sur la Fusion, Fontenay-aux-Roses, France). Phys. Fluids, 10: 2260-2(Oct. 1967).

The nonlinear processes of interaction of three electrostatic waves are investigated in a cold magnetized plasma. The experimental results agree with the theoretical conditions for the existence of the generation of waves. (auth)

1212 TRANSVERSE ELECTROMAGNETIC WAVES IN THE COSMIC-RAY GAS. Lerche, I. (Univ. of Chicago). Phys. Fluids, 10: 2271-7(Oct. 1967).

Under the assumption that the galactic magnetic field can be taken to be homogeneous, linearized equations are set up to describe the effect of a transverse electromagnetic wave on a gas composed of cold electrons and protons and relativistic protons embedded in the magnetic field. The system is assumed to be stable against electrostatic disturbances and the wave is taken to propagate normal to the unperturbed magnetic field direction. It is shown that if the perpendicular cosmic-ray pressure exceeds the parallel cosmic-ray pressure an unstable situation will result. It is also shown that the e-folding time is too long for the process to be physically insignificant. (auth)

1213 DISCONTINUITIES IN AN ANISOTROPIC PLASMA. Lynn, Y. M. (Ames Research, Moffett Field, Calif. Illinois Inst. of Tech., Chicago). Phys. Fluids, 10: 278-80(Oct. 1967).

Chew–Goldberger–Low theory is used to investigate discontinuities in an anisotropic plasma. Average ion magnetic moment is assumed to be conserved. Transition solutions and their properties for compressive shocks, contact and rotational discontinuities are given. (auth)

1214 PLASMA IRRADIATED IN A MAGNETIC FIELD. Cavaliere, A.; Giupponi, P.; Gratton, R. (EURATOM-CNEN, Rome). Phys. Lett., 25A: 636-7(Oct. 23, 1967).

A preliminary theoretical study of a plasma irradiated by a laser shows that the absorption can be significantly enhanced in an external magnetic field. (auth)

1215 OBSERVATION OF RESONANCE RECTIFICATION EFFECTS IN A MAGNETOPLASMA. Crawford, F. W.; Harp, R. S.; Mantei, T. D. (Stanford Univ., Calif.). Phys. Lett., 25A: 627-8(Oct. 23, 1967).

Resonance rectification effects for a wire probe aligned parallel to the magnetic field in a magnetoplasma are interpreted in terms of the warm plasma perpendicular permittivity component. (auth)

1216 DISPERSION OF ION–ACOUSTIC WAVES. Lonngren, K. (Univ. of Iowa, Iowa City); Montgomery, D.; Alexeff, I.; Jones, W. D. Phys. Lett., 25A: 629-30(Oct. 23, 1967). (ORNL-P-3403).

Time-of-flight measurements are made on ion–acoustic waves to determine the dispersion as the frequency increases toward the ion plasma frequency. The wave velocity shows the theoretically predicted decrease. In addition, a second, fast wave is observed, which propagates at frequencies above the ion plasma frequency, in agreement with Sessler's observations. It is suggested that the faster component may be a burst of accelerated ions. (auth)

1217 ENERGY SPECTRA OF THE IONS OF A LASER-PRODUCED ALUMINUM PLASMA. Briand, P.; Consoli, T.; Slama, L.; Grelot, P. (CEN, Saclay, France). Phys. Lett., 25A: 631-2(Oct. 23, 1967). (In French).

Plasma characteristics produced by a laser beam focalized on a solid target are measured with a pentagrid energy analyzer. (auth)

1218 RAY-OPTICAL TECHNIQUES FOR GUIDED WAVES. Maurer, S. J.; Felsen, L. B. (Polytechnic Inst. of Brooklyn). Proc. IEEE (Inst. Elec. Electron. Eng.), 55: 1718-29(Oct. 1967).

While ray-optical methods have been employed for the analysis of high-frequency radiation and scattering problems and also for the study of optical resonators, their use for description of guided modes has been less evident. A systematic procedure is presented whereby the asymptotic functional dependences and eigenvalues of modes in uniform and nonuniform guiding structures deduced by purely ray-optical means, utilizing either the eiconal and transport equations of geometrical optics or a modal consistency argument. The method is illustrated first on the simple example of a homogeneous plane slab, and is then applied to various nonuniform waveguides including an angular sector, a more general taper of either parabolic or hyperbolic shape, and a guide filled with an axially inhomogeneous dielectric. The role of caustics in the latter configurations is emphasized, and stress is placed throughout on a physical interpretation of relevant concepts which retain their validity even under conditions more general than those considered at present. (auth)

1219 INDEPENDENCE OF ION-WAVE PROPAGATION ON GEOMETRY. Lee, Kai Fong (Univ. of California, La Jolla). J. Appl. Phys., 38: 4543-4(Oct. 1967).

It is shown that the ion-wave propagation independence of transverse geometrical conditions is a direct consequence of the theory of electrostatic oscillations in bounded and inhomogeneous plasmas. (M.H.R.)

1220 STUDIES IN EXPANDED SHOCK TUBE FLOWS. I. PROBE STUDIES OF THE EXPANSION PROCESS. Bradley, J. N.; Robinson, P. A. (Univ. of Essex, Colchester, Eng.). Proc. Roy. Soc. (London), Ser. A, 301: 285-302(1967).

An apparatus for expanding high-temperature flows behind incident shock waves is described. Various types of probes for studying the low-density flows are examined and the performance of a double electrostatic probe is investigated in some detail. The characteristics of the signals obtained are interpreted in terms of the high temperature of the shock-heated gas and the expansion process. The properties of the molecular beam generated by the expansion are discussed. (auth) (UK)

1221 STUDIES IN EXPANDED SHOCK TUBE FLOWS. II. INTERPRETATION OF ION DENSITY PROFILES. Bradley, J. N.; Robinson, P. A. (Univ. of Essex, Colchester, Eng.). Proc. Roy. Soc. (London), Ser. A, 301: 303-12(1967).

Ion density profiles were obtained in expanded shock tube flows from incident shock waves in argon and in air. The rate of increase of ion density and the 'plateau' level of ion density were measured for shock waves in argon over the temperature range 3670 to 10,730°K, and in air over the range 2260 to 3790°K. The Arrhenius temperature coefficients obtained were much smaller than the ionization potentials of the major species involved, and the results are interpreted in terms of a multi-step process involving impurity ionization. The changes in the physical properties associated with the flow through the expansion, and their effect on the 'freezing' condition, are also discussed. Evidence is also presented for vibrational equilibration during the expansion process. (auth) (UK)

1222 ELECTRON–NEUTRAL HEAT TRANSFER IN PLASMAS. Nygaard, K. J. (Sperry Rand Research Center, Sudbury, Mass.). Phys. Lett., 25A: 567-8(Oct. 9, 1967).

Pulsed heat-flow experiments in afterglows of helium and xenon have yielded data on the electron thermal diffusivity. Electron-temperature transients were measured by taking advantage of the temperature sensitivity of electroacoustic (Tonks–Dattner) resonances. The results agree with Shkarofsky's theory in the limit of predominant electron–neutral collisions. (auth)

1223 SELF-ABSORPTION RESONANCES AT THE ELECTRON–CYCLOTRON HARMONICS. Landauer, G. (Inst. fuer Plasmaphysik, Garching, Ger.). Phys. Lett., 25A: 562-3(Oct. 9, 1967).

Microwave radiation patterns (f = 10.15 kMc) from a gas discharge in He show self-absorption resonances at multiples $n\omega_e$ of the electron-cyclotron frequency. (auth)

1224 ECHOES IN COLLISION-FREE PLASMAS. Gould, R. W. (California Inst. of Tech., Pasadena). Phys. Lett., 25A: 559-60(Oct. 9, 1967).

It is shown that temporal echoes can occur in collision-free plasmas at various times for different wave number combinations and that spatial echoes can occur at various positions for different frequency combinations. (auth)

1225 STABILITY OF MOTION OF A CHARGED PARTICLE IN THE SIMPLEST GEOMETRY OF A MODULATED MAGNETIC FIELD. Smirnov, Yu. N.; Frank-Kamenetskii, D. A. Dokl. Akad. Nauk SSSR, 174: 1309-12(June 21, 1967). (In Russian).

Since the motion of charged particles in time-modulated magnetic fields is of importance in plasma research, the authors investigate the stability of a charge particle moving in a field $H = H_0(1 - h \cos \gamma t)z$, where H_0 is the amplitude of the constant magnetic field, γ the modulation frequency, and h the depth of modulation, assuming a cylindrical field geometry. The differential equation is shown to be of the Hill type and goes over for small depths of modulation into a Mathieu equation, the solutions and stability of which are well known. Stability diagrams are presented for the first three instability zones. It is shown that when the depth of modulation is increased the instability zones shift towards higher modulation frequencies or towards lower natural frequencies, and the instability zones themselves become quite broad. The transverse energy of the particle increases within the instability zone. The particle energy comes from the induced electric field, and can be effective only if the motion is nonadiabatic, as is the case when the modulation frequency is of the same order as the natural frequency or higher. When the modulation frequency is low, instability can occur theoretically, but the energy transfer is very slow. The results show that the nonadiabaticity condition becomes more stringent with increasing depth of modulation, and that the most effective parametric resonance takes place when the depth of modulation is close to unity. (ATD)

1226 NONLINEAR DEMODULATION OF AN AMPLITUDE-MODULATED ELECTROMAGNETIC WAVE IN A PLASMA. Ram, Sant; Arora, A. K. (Indian Inst. of Tech., New Delhi). Can. J. Phys., 45: 2543-59(Aug. 1967).

The expression for the electric vector was derived when an amplitude-modulated electromagnetic wave propagates in a nonlinear dispersive medium. Demodulation is obtained in the case of a wave propagating in a nonlinear medium, whereas overmodulation has been obtained when the wave is reflected back in the free space from a plasma free-space interface. Some calculations have been performed in both cases and it has been found that the demodulation decreases with increasing electron density, with increasing index of modulation of the incident wave, and with increasing collision frequency. In the case of reflection the overmodulation is found to decrease with decreasing electron density, increasing index of modulation, and decreasing collision frequency inside the plasma. The calculated results have been presented in the form of tables in the discussion. (auth) (Canada)

1227 ELECTROMAGNETIC WAVE REFLECTION FROM IONIZATION FRONT. Semenova, V. I. (Scientific-Research Radiophysics Inst., Gorky, USSR). Izv. Vyssh. Ucheb. Zaved., Radiofiz., 10: 1077-86(1967). (In Russian).

Reflection of plane electromagnetic waves is considered at a normal incidence on a sharp plasma boundary formed by a moving source of ionization. There has been found the reflection coefficient of plasma half-space in which the plasma density behind the front remains constant or increases under the source action. Reflection from a moving boundary behind which the density decreases as a result of recombination or electron attachment is also investigated. The coefficient of reflection from a finite-thickness layer with a constant density of charged particles has been calculated. (auth)

1228 ELECTROMAGNETIC FIELD PENETRATION INTO MAGNETOACTIVE PLASMA. Kondratenko, A. N. Izv. Vyssh. Ucheb. Zaved., Radiofiz., 10: 1096-1109(1967). (In Russian).

In the approximation of a weak spatial dispersion the author considers the problem of electromagnetic wave propagation through the plasma in a constant magnetic field parallel to the plasma boundary when magnetic vector of an incident wave is parallel to the constant field. The absorption coefficient of the wave energy was determined for different partial cases. Longitudinal wave excitation was considered. (auth)

1229 INFRARED EMISSION OF CO_2–N_2 AND CO_2–N_2–He PLASMAS. McCubbin, T. K. Jr.; Hahn, Yu Hak (Pennsylvania State Univ., University Park). J. Opt. Soc. Amer., 57: 1373-75 (Nov. 1967).

A high-resolution spectroscopic study has been made of the emission in the 4.3-μ region of electrically excited CO_2–N_2 and CO_2–N_2–He plasmas. CO_2-rich plasmas emit an intense spectrum in which P-branch and low-J R-branch lines appear in absorption. The R-branch band heads ($J \cong 120$) appear as emission features in such spectra and there is a region of mixed absorption and emission. CO_2–Ne plasmas that would sustain laser oscillations in a suitable cavity exhibit emission lines and derive most of their intensity from the fundamental and four hot bands of the naturally abundant CO_2 isotope. With the mixture ratio and pressure carefully adjusted, the CO_2–N_2–He plasma emits lines of the $00^03 - 00^02$ and $00^02 - 00^01$ bands. Bands from $^{13}C^{16}O_2$, $^{12}C^{16}O^{18}O$, and $^{13}C^{16}O^{18}O$, which are prominent in the CO_2 absorption spectra, do not appear in the plasma spectra. The molecular constants ω_3^0, x_{33}^0, and y_{333} are derived from bands in the $00v_3 - 00(v_3-1)$ sequence. (auth)

1230 CROSS WAVE OF MOVING STRIATIONS IN THE PLASMA OF A POSITIVE COLUMN. Stirand, O.; Laska, L. (Inst. of Physics, Prague). Czech. J. Phys., 17: 928-30(1967).

A peculiar wave of moving striations (ionization waves) was found to form in the hydrogen plasma of a positive column of a dc discharge in the diffusion regime. It was excited aperiodically by a small disturbance of the electric field at the point of homogeneity of the equilibrium positive column. Wave measurements made by moving the disturbance showed that this cross wave propagates away from the disturbance point. The cross wave appears to be two separate waves, the forward part and the backward part; by changing the plasma parameters and amplification, one may obtain only one or the other. The origin of the cross wave is elucidated by considering the dispersion properties of the medium near $\omega = 0$. The extensions of the dispersion curves of the forward and backward parts form an inflection point corresponding to standing striations. Thus, the cross wave has a phase velocity which changes sign at the inflection point. The necessary condition for the origin of the cross wave is the existence of a maximum or minimum of the group velocity of the corresponding inflection point on the dispersion curve. (D.L.C.)

1231 NONLINEAR WAVES IN BEAM–PLASMA SYSTEM. Fainshtein, S. M. (Gorky State Univ., USSR). Izv. Vyssh. Ucheb. Zaved., Radiofiz., 10: 1110-14(1967). (In Russian).

Stationary nonlinear waves in a heated plasma pierced by a quasi-neutral beam of charged particles are considered. Solitary waves are shown to exist in such a system under definite conditions. Calculation of structure of these waves is made for typical parameters of the solar corona. (auth)

1232 REVISION OF THE TEMPERATURE DEPENDENCE OF THE IONIZATION RATES OF NEON IONS. Hinnov, Einar (Princeton Univ., N. J.). J. Opt. Soc. Amer., 57: 1392(Nov. 1967).

In a recent paper [J. Opt. Soc. Amer., 56: 1179-88(1966)] on the ionization rates of neon ions, an error was made in evaluation of the electron temperature from the electrical conductivity of the stellarator plasma. The average $\Sigma_j Z_j N_j / \Sigma_j N_j$ was used instead of rms value $Z_{eff} = \Sigma_j Z_j^2 N_j / \Sigma_j Z_j N_j$. The corrected values of the ionization rate coefficients are more self-consistent and allow deduction of probable values of the assumed constants b_j that give the magnitude of the cross section for ionization $N^{j+} \rightarrow N^{(j+1)+}$. These probable values are 1.0, 1.6, 2.0, 2.8, and 2.3 for b_2, b_3, b_4, b_5, and b_6 respectively. (A.G.W.)

1233 RADIATION FROM AN ELECTRIC DIPOLE IMMERSED IN A LOSSY ANISOTROPIC PLASMA. Freire, Gabriel F. (Instituto Technologico de Aeronautica, Sao Paulo, Brazil); Scarabucci, R. R. Int. J. Electron., 22: 65-80(1967).

The radiation characteristics of an electric dipole immersed in an unbounded, homogeneous, anisotropic plasma are investigated for the case in which an infinitely strong static field is applied to the plasma, ions are stationary and collision effects are taken into account. Under an infinite dc magnetic field directed along the z-coordinate axis the dielectric tensor is complex and diagonal, characterizing a dissipative uniaxially anisotropic medium. Under these assumptions the problem is solved for the cases in which the electric dipole is respectively parallel and perpendicular to the z-axis. In both cases far-field expressions are derived from that of the arbitrarily oriented dipole case. It is noted that the presence of small losses by collisions in the plasma may have appreciable effects on the radiation patterns. Besides the reduction in gain due to collisional damping, the radiation peaks are shown to be shifted when small collision effects are introduced. (auth) (UK)

1234 RADIATION FROM LINEAR NON-RESONANT ANTENNA IN WEAKLY IONIZED PLASMA. Talekar, V. L. (Malaviya Regional Engineering Coll., Jaipur, India). Int. J. Electron., 22: 81-9(1967).

In earlier studies relating to the radiation from antenna immersed in weakly ionized plasma, a linear resonant centre-fed antenna was used as source. In the present work, a thin, linear, nonresonant end-fed antenna is investigated under similar conditions. A theoretical study of its radiation resistance for electromagnetic and electro-acoustic waves is made, taking the propagation constant as complex for both these modes. The effect of electron neutral particle collision is also taken into consideration wherever effective. It is shown that the effect of plasma is more profound when the source frequency is lower than the plasma frequency; but at frequencies higher than the plasma frequency the effect is found to be not of much consequence. General expressions of radiation resistance for both the electromagnetic and the electro-acoustic waves are obtained, and from these the behavior of half-wave linear nonresonant end-free antennas is deduced. These results are then compared with those for half-wave centre-fed dipoles. (auth) (UK)

1235 OBSERVATION OF ANOMALOUS ELECTRON HEATING IN PLASMA SHOCK WAVES. DeSilva, A. W.; Stamper, J. A. (Univ. of Maryland, College Park). Phys. Rev. Lett., 19: 1027-30(Oct. 30, 1967).

Direct observations are reported of the electron velocity distribution throughout the region traversed by a magnetic shock wave in a plasma. In one case, the electron heating rate is greater than 10 times that predicted from normal and compressional effects. (auth)

1236 ANNIHILATION OF A TWO-DIMENSIONAL JET BY A TRANSVERSE MAGNETIC FIELD. Moffatt, H. K.; Toomre, J. (Cambridge Univ., Eng.). J. Fluid Mech., 30: 65-82(Oct. 17, 1967).

The effect of an applied transverse magnetic field on the development of a two-dimensional jet of incompressible fluid is examined. The jet is prescribed in terms of its mass flux ρQ_0 and its lateral scale d at an initial section x = 0. The three dimensionless numbers characterizing the problem are a Reynolds number $R = Q_0/\nu$, a magnetic Reynolds number $R_m = \mu\sigma Q_0$, and a magnetic interaction parameter $N = \sigma B_0^2 d^2/\rho Q_0$, where ρ represents density, σ conductivity, μ permeability and B_0 applied field strength, and it is assumed that $R_m \ll 1$, $R \gg 1$, $N \ll 1$. It is shown that, when $M^2 = RN \gg 1$, an inviscid treatment is appropriate and that the effect of the magnetic field is then to destroy the jet momentum within a distance of order N^{-1} in the downstream direction. A general solution for inviscid development is obtained, and it is shown that a large class of velocity profiles (though not all of them) are self-preserving. When $M^2 \ll 1$ it is shown that the viscous similarity solution obtained by Moreau is relevant. This solution is re-derived and re-interpreted; it implies that the jet momentum is destroyed within a distance of order $R^{\frac{1}{3}}N^{-\frac{1}{3}}$ in the downstream direction. Some further aspects of the jet annihilation problem are qualitatively discussed, viz. the nature of the overall flow field, the effect of the presence of distant boundaries, the effect of increasing R_m to order unity and greater, and the effect of oblique injection. The development of a jet of conducting fluid into a nonconducting environment is considered; in this case the jet is not stopped by the magnetic field unless a return path outside the fluid for the induced current is available. (auth) (UK)

1237 CONSTRICTED POSITIVE COLUMN OF A NON-EQUILIBRIUM ELECTRIC DISCHARGE IN ALKALI–METAL-SEEDED RARE GASES. Ellington, H. I. (Robert Gordon's Inst. of Tech., Aberdeen, Scotland). Brit. J. Appl. Phys., 18: 931-7(July 1967).

The existence in alkali-metal-seeded rare gases of a mode of the nonequilibrium electric discharge with a constricted positive column is demonstrated and its structure is discussed. The positive column is shown to have a minimum stable current and to expand as the current increases, in such a way that the mean current density remains roughly constant over a fairly wide current range. As the current rises, the column electric field falls inversely as the square root of the current. The energy balance of the column is discussed, and the fall in electric field with rising current is explained in terms of the heat losses at the column boundary. The gas temperature of the column is also discussed and is shown to be higher than the temperature outside the column and to rise as the column axis is approached. The axis temperature is shown to rise as the current increases. The experimental observation that the mean electrical conductivity of the column plasma rises as the current increases, despite the fact that the column field falls, is explained in terms of the above facts. The effect on the energy balance and electrical conductivity of changing the rare gas is discussed, and agreement between theory and experiment is shown. (auth)

1238 EXCITATION AND IONIZATION IN NONEQUILIBRIUM PLASMAS. Drawin, H.-W. (CEN, Fontenay-aux-Roses, France). Atompraxis, 13: 413-18(Sept. 1967). (In French).

A short review is given on the present work on the thermodynamics of ionized gases (plasmas) which deviate from local thermodynamic equilibrium. During the past years, the general interest in this field of special research has considerably increased. The main stimuli came from different directions: (1) Research on high-temperature plasmas especially in connection with the attempts to realize a thermonuclear fusion of light nuclei under controlled laboratory conditions; (2) Research on electrical power production in so-called MHD converters; (3) Development and optimization of the efficiency degree of different types of lasers; (4) Recent work on plasma burners for the potential propulsion of space crafts; (5) Extraterrestrial research and special problems of astrophysical interest. The problems are so manifold and different that they are not treated in detail; only the general principles of excitation and ionization are outlined. A detailed list of references of the most important publications of the last few years is included. (auth)

1239 SOME PARTIAL SOLUTIONS OF EQUATIONS DESCRIBING AXIALLY SYMMETRIC MOTIONS OF A GRAVITATING RAREFIED PLASMA. Ryazanov, E. V. Dokl. Akad. Nauk SSSR, 175: 309-11(July 11, 1967). (In Russian).

Axial-symmetric unstable motion of a gravitating plasma in the presence of a magnetic field was studied considering that the vector of magnetic field intensity is perpendicular to trajectories of the particles. Equations were constructed for the cases in which magnetic flux lines were straight lines parallel to the axis of symmetry, concentric circumferences with their centers on the axis of symmetry, or helical lines. (R.V.J.)

1240 CONTRIBUTION OF THE SECOND VIRIAL COEFFICIENT TO THE FREE ENERGY OF A HIGH-TEMPERATURE PLASMA. Kelbg, G.; Hetzheim, H. (Univ., Rostock, Ger.). Ann. Phys. (Leipzig), 20: 68-70(1967). (In German).

With a pseudo potential derived recently, the contribution of the second virial coefficient to the free energy of a high-temperature plasma is calculated. The assumption is that the fundamental lengths are ordered as $e^2/kT < \lambda_{therm.} < r_{Debye}$. The contributions are of the order of e^6 in the charge parameter. (auth)

1241 INTERACTION BETWEEN IONIC AND ELECTRON WAVES IN A PLASMA. Sudano, Jose Pantuso (Institut d'Astrophysique, Paris). Compt. Rend., Ser. A and B, 264: 1706-8(June 19, 1967). (In French).

In the linear hydrodynamic approximation the dispersion relation of the longitudinal electron branch does not contain terms due to the contribution of ion oscillations. In the nonlinear theory reported here, a dispersion relation containing a term due to the oscillations of ions is found. (tr-auth)

1242 THEORY OF THE ELECTROMAGNETIC FLUCTUATIONS IN A HALF-BOUNDED PLASMA. Kotsarenko, N. Ya.; Fedorchenko, A. M. (Kiev State Univ.). Ukr. Fiz. Zh., 12: 1533-8(Sept. 1967). (In Russian).

The electromagnetic fluctuations, surface waves included, in a half-bounded plasma are considered. The analysis shows that: there exist fluctuations of the surface waves in the region $0 < \omega < \omega_p/\sqrt{2}$ (ω_p–langmuir frequency); at $\omega = \omega_p$ there are δ-like fluctuations of plasma oscillations; at $\omega > \omega_p$ there exist fluctuations of electromagnetic volume waves; and there are no fluctuations in the region $(\omega_p/\sqrt{2}) < \omega < \omega_p$ if dissipative processes and space dispersion are neglected. (auth)

1243 ELECTROMAGNETIC WAVE ABSORPTION AND TRANSFORMATION IN A RESONANT LAYER AT OBLIQUE INCIDENCE ON A NONUNIFORM PLASMA. Omelchenko, A. Ya.; Stepanov, K. N. (Inst. of Physics and Tech., Kharkov). Ukr. Fiz. Zh., 12: 1445-53(Sept. 1967). (In Russian).

A behavior of electromagnetic waves in a resonant layer of a nonuniform plasma where wave frequency is equal to the plasmic one is considered at oblique incidence of waves on a semi-infinite plasma. Coefficients of wave absorption are determined in case of a thin layer (the layer depth is considerably less than a wavelength) for an arbitrary incidence angle, and in case of nearly right incidence angle on a plasma with slowly changing density. The field behavior is determined in a resonant region with space dispersion, when collision frequency is small and the generation of plasmic waves should be taken into account. (auth)

1244 FYZIKA PLAZMATU. (Plasma Physics). Kracik, Jiri; Tobias, Jaromir. Prague, Academia, Nakladatelstvi Ceskoslovenske Akademie Ved, 1966. 261p.

Experimental and theoretical concepts of plasma physics are reviewed. The Liouville and Boltzmann kinetic equations, energy conservation laws, equilibrium state statistics, charged-particle interactions, solutions for various kinetic equations, plasma viscosity, relativistic plasma, and magnetohydrodynamics and plasma dynamics are discussed. (R.V.J.)

1245 OPTICAL EMISSION FROM A CHARGED PARTICLE SLOWING DOWN IN A PLASMA. Ptak, Roger Leon. Ithaca, N. Y., Cornell Univ., 1966. 63p.

Thesis.

Calculations are made for an alpha particle slowing in two types of plasma. The first plasma model consists of completely ionized H at $T = 10^5$°K. The second model has 90% H all ionized and 10% singly ionized He, with $T = 5 \times 10^4$°K. Total yields for various lines are calculated. The line shape for the case of isotropic alpha particles and for the case of a beam of particles was observed. An Fe particle is chosen as an example of a heavy ion, and estimates are obtained for total optical emission by the various ionization stages that are important as the Fe ion slows from 50 to 1 MeV. It was found that the radiation yields are quite small. As the alpha particle goes from 10 MeV to thermalization, the total yield in the brightest visible line of He II is only about 10^{-4} eV for the first plasma model, and about 1 eV for the second model. The total yield in visible lines for Fe ion is about 100 eV. The intensity of the emission from an alpha particle with a velocity around 10^9 cm/sec or less is very sensitive to the plasma temperature, if kT is less than the excitation energy. A beam of such particles should thus prove useful as a plasma diagnostic tool. (Dissert. Abstr.)

1246 ELECTRON DENSITY GROWTH IN AN INITIALLY TENUOUS PLASMA IN RESPONSE TO A SUDDENLY APPLIED ELECTROMAGNETIC WAVE. Bradley, Laird Powell. Philadelphia, Univ. of Pennsylvania, 1966. 159p.

Thesis.

The transient electron growth in an unbounded, initially weakly ionized plasma under the influence of an intense, suddenly applied electromagnetic wave is theoretically analyzed. The mutual interaction of the applied field and electron density created by its leads to a nonlinear formulation, and an illustrative case is therefore numerically examined. The case consists of an antenna focused in the D region of the ionosphere. The results of a one-dimensional analysis, axially representative of the discharge, and a three-dimensional analysis are detailed with the following notable points. In response to the applied field, a plasmoid is generated which grows first exponentially in magnitude, and abruptly commences to move toward the source at approximately constant velocity. In magnitude, the peak density reaches a maximum and then relaxes to its lower steady-state value. An analytic expression is given which describes the evolution of the peak density. It is shown that the electronegative gas, through enhanced attachment, is responsible for the formation of a negative ion sheath completely surrounding the focal discharge, and its consequences are examined. (Dissert. Abstr.)

1247 COLLISIONS IN IONIZED GASES. Lewis, Jordan David. Ann Arbor, Mich., Univ. of Michigan, 1966. 176p.

Thesis.

A study of the description and effects of particle interactions in ionized gases is presented. The principal results are: (i) An expansion theorem for the linearized Fokker–Planck collision operator for each component of a two-component fully ionized gas, and (ii) A description of photon scattering from a partially ionized gas. It is shown that the Fokker–Planck collision operator generates a complete, continuous set of velocity-space eigenfunctions, for which high-speed asymptotic forms are found. Since the set is continuous, the expansion formula has the form of a generalized Fourier integral. The effect of neutral atoms on the spectrum of photons scattered by electrons in a partially ionized gas is shown to be primarily a reduction in height and increase in width of the two electron-plasma "wings." The scattered photon spectrum is described for several characteristic cases. (Disser. Abstr.)

1248 TRANSPORT PROPERTIES OF NONEQUILIBRIUM PARTIALLY IONIZED GAS. Chmieleski, Robert Marshall. Stanford, Calif., Stanford Univ., 1967. 131p.

Thesis.

A modified Chapman–Enskog approach for an ionized gas is presented. This method consists of using the Boltzmann equation and assuming a solution in the form of the usual Chapman–Enskog ansatz. The modification is contained in the treatment of the various collision terms. It is demonstrated that because of the small electron-to-heavy-particle mass ratios, cross collisions in the heavy-particle equations can be ignored. In the electron equation, a series expansion of the heavy particle Maxwellians are used to split cross-collision terms into various orders of the expansion parameter ϵ. The method allows the electron and heavy-particle temperatures to differ while requiring all species to have the same macroscopic velocity to zero order. Expressions are obtained for the transport properties of such a gas in the presence of an electric field and in the presence of both electric and magnetic fields. In both cases a complete set of self-contained hydrodynamic equations is given. As an example, the transport properties of a fully ionized gas containing a single ion species are evaluated using the cut-off Coulomb potential. In the limit of equal electron and ion temperatures, the results are in agreement with previous results. The case in which there is a possibility of having several different temperatures is also given some consideration. (Disser. Abstr.)

Production of Plasma

Refer also to abstracts 1030 and 1200.

1249 (LA–3770, Paper G3) COLUMBA: A HIGH-TEMPERATURE Z-PINCH EXPERIMENT. Phillips, J. A.; Schofield, A. E.; Tuck, J. L. (Los Alamos Scientific Lab., N. Mex.). 5p.

So far the existence of elevated temperatures (~5 keV) in z pinches has not been established through in θ pinches, especially in those of high E_θ, such temperatures are well known and appear to impart good behavior. In the Columba experiment the high-temperature plasma of a θ pinch was used as the starting point for a z-pinch compression. The θ pinch is of conventional Scylla design: tube length 28 cm, inside diameter 8 cm, with B_z magnetic field rising to a peak of 56 kG in 2 μsec. The z pinch, turned on at selected times in the θ-pinch cycle, can provide currents of 400 kA with rise times of 8 μsec. The experiment is in the preliminary stages of operation. The indications are that the initial z-pinch current does not flow along the discharge tube wall as in conventional z pinches but along the B_z magnetic lines joining the z-pinch electrodes. At low B_z fields and z currents the z-pinch radius then closely follows the θ-pinch field, i.e., minimum radius with maximum B_z pressure and maximum radius when the B_z field passes through zero. At high B_z fields and z currents the added magnetic pressure from the z-current further compresses the plasma column and reduces the B_z field between the plasma and the coil. (auth)

1250 (LA–3770, Paper C1) SOME CHARACTERISTICS OF THE DENSE PLASMA FOCUS. Mather, J. W.; Bottoms, P. J.; Williams, A. H. (Los Alamos Scientific Lab., N. Mex.). 5p.

The production of hot dense deuterium plasmas $2 \times 10^{19} < n < 2 \times 10^{20}$ with electron temperatures $T_e > 5$ keV have been reported,

using a combination of hydromagnetic plasma acceleration and the fast z-pinch effect. The electrical resistance of the current sheath during the acceleration phase and final collapse process has been measured. Values of resistance prior to the moment of collapse and during the last few tenths of centimeters of radial collapse are $\sim 50 \times 10^{-4}$ ohms and $\sim 8 \times 10^{-3}$ ohms respectively. The former value corresponds to $T_e \sim 60$ eV. The plasma emits a copious supply of x rays with energies up to ~60 keV. If x rays of energies $\gg 60$ keV are produced, their contribution appears negligible in comparison. A bent-crystal x-ray spectrometer is being used to determine the spectral distribution of the x-ray source. Hydrodynamic models are now available which show qualitatively the dynamical behavior of the dense plasma focus device; however, the heating of the plasma electrons to temperatures $T_e \sim 5$ keV is not predicted by these models ($\omega\tau > 1$). Other heating schemes are discussed. (auth)

1251 (LA–3770, Paper D4) LOW-ENERGY THETA PINCH. DeSilva, A. W.; Kunze, H.-J. (Maryland Univ., College Park). 8p.

A low-energy theta-pinch device, constructed to provide a convenient spectroscopic source, has produced an interesting and useful plasma. The discharge tube has an inside diameter of 15 cm and the coil is 32 cm long. The main bank energy is 9 kJ at 40 kV, and the current rings with a 7.5-μsec period. Plasma conditions have been investigated for a filling gas pressure of .012-torr H_2 or D_2 and an antiparallel bias field of 500 gauss using light scattering, time and space resolved emission spectroscopy in the visible and soft x-ray regions of impurity lines (~1%C, 3%O), streak photography, and neutron emission. These reveal that following the initial compression the plasma forms a stable cylinder about 4.5 cm in diameter which persists for about 1.5 μsec. The electron temperature, determined by light scattering, is about 260 eV. Absolute continuum emission and light scattering measurements show the average electron density to be 4×10^{15} cm^{-3}. The temperature of carbon impurity ions is determined to be 1.3 keV by Doppler broadening, and neutron emission with a deuterium filling indicates an ion temperature of about 700 eV. (auth)

1252 (LA–3770, Paper E2) COAXIAL GUN DEVELOPMENT. Henins, I.; Henry, P. S.; Lohr, J.; Marshall, J. (Los Alamos Scientific Lab., N. Mex.). 5p.

In the past the coaxial gun has been used to produce an energetic (10 keV) plasma with a total yield of approximately 5×10^{17} deuterons. The aim here has been to increase the energy and quantity of the fast plasma. To increase the energy, a higher voltage than the usual 20 kV needs to be applied to the gun. This is difficult because of insulation problems at the current feed through the vacuum tank wall. One way to overcome this is to store the energy in a magnetic field inside the vacuum tank and then use this field energy to generate the necessary voltage and current to accelerate plasma. Various methods of this kind of energy storage have been investigated, but can not yet be applied to a practical gun design. The quantity of plasma should increase with increased gun dimensions and capacitor bank energy. A large coaxial gun, twice the linear dimensions of the previous one, has been built and its behavior is being investigated. (auth)

1253 (LA–3770, Paper E5) PREIONIZATION PHENOMENA IN PULSED PLASMA ACCELERATOR. Lie, T. N.; Rhee, M. J.; Chang, C. C. (Catholic Univ. of America, Washington, D. C. Dept. of Space Science and Applied Physics). 4p.

Appreciable level of pre-ionization in the cold gas ahead of the propagating current sheet in both accelerators of coaxial- and parallel-plate geometry was detected, using monochromators and probes for four different working gases. The origin of the preionization is inferred to be due to a prebreakdown ionization buildup in the whole electrode gap. The ionization grows rapidly to a point of breakdown but since the breakdown usually occurs near the insulator, the remaining part of the electrode gap maintains the ionization until it encounters the current sheet and undergoes intense heating. The pre-ionized media ahead of the current sheet may cause unexpected behavior of the current sheet. A possible explanation using the experimental results is given for the current sheet tilt in the parallel-plate accelerator and for the polarity effect in the coaxial accelerator. (auth)

1254 (LA–3770, Paper F5) PRODUCTION AND MAGNETIC FIELD CONFINEMENT INVESTIGATIONS OF LASER-IRRADIATED SOLID-PARTICLE PLASMAS. Haught, Alan F.; Polk, Donald H. (United Aircraft Corp., East Hartford, Conn. Research Labs.). 5p.

The focused beam of a Q-spoiled ruby laser has been used to form a high-temperature, high-density plasma from a single 10- to 20-μ diameter particle of lithium hydride, which is electrically suspended in a vacuum environment. From time resolved charge collection measurements, the plasma expands as a ball and is essentially spherically symmetric in both density and expansion velocity. Velocities up to 4×10^7 cm/sec, corresponding to average plasma energies of over 200 eV, have been measured. Calculations of the plasma formation and expansion have been made using both a spherically symmetric hydrodynamic model and an integrated similarity model, and give results in very good agreement with those observed experimentally. Measurements have been carried out examining the interaction of these plasma with confinement magnetic fields of mirror and minimum-B geometry at field strengths up to 8 kG. The results obtained indicate the confinement of a ~200 eV thermalized plasma with a density of $\sim 10^{13}$ cm^{-3} for times of respectively 5 and 10 μsec in the 8-kG mirror and minimum-B magnetic fields. (auth)

1255 (LA–3770, Paper F6) LASER–THERMONUCLEAR FUSION EXPERIMENT. Bryner, J. C.; Sichling, G. H. (North American Aviation, Inc., Downey, Calif.). 5p.

A series of experiments has been carried out to domonstrate the feasibility of producing thermonuclear reactions by heating fusionable material with an intense laser beam. The plasma was produced in a 10^{-7}-torr vacuum by a 500-MW pulsed, ruby laser. The laser pulse width was measured at 10 to 15 nanoseconds. A specially designed lens system focused the laser beam onto a LiD pellet of about 0.1 mm dimension, which resulted in an intensity of about 4.5×10^{12} watts/cm^2. Time-of-flight measurements indicated velocities which were sometimes in excess of 10^7 cm/sec and kinetic energies of several kilovolts per ion in the expanding plasma cloud. A special purpose integrating scintillation counter was constructed to detect neutrons produced in d–d reactions. No neutrons were detected by this device in any of the experiments. This result indicates that fewer than 1000 thermonuclear reactions took place and that the peak plasma temperature was below 330 eV. (auth)

1256 (LA–3770, Paper H2) BREAKDOWN AND PREIONIZATION STUDIES FOR A MEGAJOULE THETA PINCH AT LOWER DENSITIES. Eberhagen, A.; Koeppendoerfer, W.; Muenich, M. (Institut fuer Plasmaphysik, G.m.b.H., Garching (West Germany)). 6p.

Two fast z pinches of 80- and 120-kV charging voltage as a preheating system have been examined. The 80-kV pulse provides breakdown down to a pressure of 5 micron. This discharge collapses extremely rapidly at low electron densities and forms a narrow discharge channel which lacks reproducibility. The 120-kV z pinch then heats the gas and brings up ionization. By proper timing of this discharge reproducibility could be established for pressures down to 10 micron. (auth)

1257 (LA–3770, Paper H6) PREIONIZATION STUDIES IN A LARGE INVERSE PINCH. Sorrell, F. Y.; Vlases, G. C.; Crawford, E. A. (Colorado Univ., Boulder). 8p.

Several approaches to the problem of preheating hydrogen in a 50-cm diameter inverse pinch tube are discussed. The goal is to create a uniform, fully ionized plasma in equilibrium at a temperature of 1.5 eV or higher and a density on the order of 10^{15} electrons cm^{-3} for collisionless shock wave studies. Preionization is accomplished by discharging a preheat capacitor bank through the same electrode system as is used for the shock bank. Time and space resolved determination of the electron density has been made by measuring the Stark broadening of H_β with a scanning Fabry–Perot interferometer. The electron is determined by photoelectric spectroscopic measurements of relative intensities. Finally, the total plasma density is estimated from the trajectories of shock waves propagating in the preheated gas. The measurements indicate that a high-current, short-duration discharge, in which the heating is primarily by strong shock waves, is more efficient in ionizing the gas than is a slow pulse in which the heating is primarily Ohmic. With shock heating it appears possible to achieve nearly full ionization at a temperature of 1.5 to 3 eV over about two thirds of the chamber. With a long, slow current pulse, either oscillating or crowbarred, densities are significantly lower even though the total energy in the bank may be several times that used in the fast pulse configuration. (auth)

1258 (LA–3770, Paper H7) HIGH-DENSITY PLASMA INDUCED BY PULSED MICROWAVE. Block, R. B.; Rode, D. L.; Mawardi, O. K. (Case-Western Reserve Univ., Cleveland, Ohio). 6p.

A high mirror-ratio coil used in a θ-pinch experiment was adapted as a spherical microwave resonator to produce intense preionization by a high-power microwave discharge. The initial breakdown is triggered by an X-band pulse of .22-μsec duration and 325-kW peak power. This is followed by an S-band pulse 1.3-μsec long at 800-kW peak power. Theory shows that the transverse magnetic resonant modes yield the largest magnitude electric fields, these being radial. The predicted TM_{22m} and TM_{11m} modes have been observed experimentally to be well coupled to

the cavity when the S-band pulse is incident upon a low-density plasma. Electron densities are measured by Langmuir probes and an infrared wavelength interferometer, the latter indicating densities of 10^{14} cm^{-3} at a base pressure of 80 μ in helium, although breakdown occurs even well below 10 μ. In addition the skin depth, the electron temperature, and the Q of the cavity have been measured and are in close agreement with the theory. Substantially higher percentages of ionization are believed to be produced at the lower pressures as the total number of electrons produced is fairly insensitive to the base pressure and breakdown was observed to occur well below 10 μ. (auth)

1259 CATAPHORETIC PURIFICATION OF GASES. Freudenthal, J. (State Univ., Utrecht, Netherlands). J. Appl. Phys., 38: 4818-22(Nov. 1967).

Two types of purification devices for gases are described. The purification effect is based on the cataphoretic segregation in the positive column of a low-pressure discharge. This segregation as a function of time is given in terms of the tube current, gas pressure, and the tube dimensions. From them optimum conditions can be chosen for a high final purity and a high purification velocity. Experimental results of the segregation in a discharge in neon with an impurity of argon are given. (auth)

1260 ALKALI METAL PURIFICATION BY PREFERENTIAL CONTACT IONIZATION IN A MAGNETOPLASMA DEVICE. Schmidt, P. H. (Bell Telephone Labs., Inc., Murray Hill, N. J.). Granatstein, V. L.; Eastlund, B. J.; Leheny, R. F. J. Appl. Phys., 38: 4949-20(Nov. 1967).

A separation technique based on differences in ionization potential between a desired element and its impurities is explored. Preliminary considerations indicate that a purification device based on this principle should provide for preferential ionization of the desired component and production of a plasma. With a plasma, larger theoretical material transfer rates should be feasible. Impurities or nonionized particles could be discriminated against by collecting the plasma species in a collector of proper geometrical design. (M.H.R.)

1261 PRIMARY IONIZATION COEFFICIENT OF DEUTERIUM. Morgan, C. Grey; Powell, W. D.; Williams, W. T. (University Coll. of Swansea, Wales). Brit. J. Appl. Phys., 18: 939-43(July 1967).

Ionization currents in purified deuterium between plane parallel gold electrodes at separations up to 1.2 cm were measured in the range $47 \leq E/p_0 \leq 165$ v cm^{-1} $torr^{-1}$ and $1.55 \leq p_0 \leq 18.4$ torr, where E is the applied electric field and p_0 the gas pressure (corrected to 273°K). The values of the primary ionization coefficient α/p_0 deduced by three methods from these measurements are compared with results of other workers. Within the limits of experimental error, α/p_0 was found to be a function of E/p_0 only. (auth)

1262 LASER-PRODUCED PLASMAS FROM ISOLATED SOLID HYDROGEN PELLETS. Francis, G.; Atkinson, D. W.; Avivi, P.; Bradley, J. E.; King, C. D.; Millar, W.; Saunders, P. A. H.; Taylor, A. F. (United Kingdom Atomic Energy Authority, Abingdon, Eng.). Phys. Lett., 25A: 486-7(Sept. 25, 1967).

A 500-MW pulsed ruby laser is focused on an isolated solid hydrogen pellet in vacuo. The launching and timing mechanisms are described. The resulting plasma expands spherically with a front velocity of 2×10^7 cm/sec. The number of ions in the plasma exceeds 5×10^{16}. (auth)

1263 BALLISTIC AERODYNAMIC AND SPECTROSCOPIC INVESTIGATION OF AN RF ARGON PLASMA SOURCE INTENDED FOR A MAGNETOHYDRODYNAMIC MEDIUM. Henderson, Dale Barlow. Ithaca, N. Y., Cornell Univ., 1967. 68p. Thesis.

Desiring a facility for magnetohydrodynamic (MHD) experiments, an rf argon plasma generator was built in combination with a ballistic range. Spheres are photographed in free flight (at approximately 2 km/sec) through the magnetized plasma with an image converter camera. From analysis of these photographs, the state of the neutral gas is deduced; from analysis of the spectra, the state of the electron gas is deduced. The resulting plasma properties, which were not known in advance, are not sufficient for interesting MHD experiments as is shown by an examination of the appropriate theories. A model for the structure of this type of plasma is constructed from these data using a kinetic theory approach. This model features a neutral gas temperature which is uniform over most of the plasmoid and an electron temperature which is elevated by some 900°K in the outer skin depth. This model is not in agreement with previous studies of similar plasmas, these previous studies lacking any direct knowledge of the neutral gas state. (Disser. Abstr.)

Stability of Plasma

Refer also to abstract 1138.

1264 (LA-3770, Paper A7) END STABILIZATION EFFECT IN THE SLOW THETA PINCH. Hamada, Shigeo; Miyamoto, Tetsu; Ohnishi, Haruyuki; Sato, Masatomo (Nihon Univ., Tokyo). 4p.

Existence of a stabilization effect due to the plasma near and outsides mirror points is shown by experiments dispacing a driving magnetic field or excluding the outer plasma by glass plates. The effect is not the so-called line tying effect. Effects of an inclined glass plate and a funnel shaped glass cone were examined. The former pushes the plasma column towards the side of the obtuse angle between its surface and lines of force, and the latter stabilizes the plasma. Theoretical results are briefly described in stability of an unsteady plasma flow along lines of force and in a motion of unsteady plasma string. The results are consistently compared with the experimental results. (auth)

1265 (LA-3770, Paper B1) STABILITY OF THE THETA PINCH. Wesson, John (United Kingdom Atomic Energy Authority, Abingdon (England). Culham Lab.). 4p.

In a toroidal theta pinch it is inevitable that regions having favorable stability properties alternate along its length with regions having unfavorably stability properties. Owing to the complexity of such configurations it is useful to consider a linear theta-pinch with similar properties. The simplest case is that of an axisymmetric pinch which is periodic along its length and which has no axial current. The known hydromagnetic stability properties of this configuration are summarized. (auth)

1266 (LA-3770, Paper B2) HYDROMAGNETIC EQUILIBRIUM OF A THIN-SKIN, FINITE BETA TOROIDAL PLASMA COLUMN. Johnson, J. L. (Princeton Univ., N. J. Plasma Physics Lab.); Morse, R. L.; Riesenfeld, W. B. (Los Alamos Scientific Lab., N. Mex.). 5p.

An analytic approach to the problem of describing the toroidal equilibrium of a finite beta plasma column in the hydromagnetic approximation is discussed. The thickness of the sheath region separating the plasma from the external magnetic field is assumed to be negligibly small compared to all other dimensions (the "thin-skin" approximation). The deviations of this interface from toroidal cylindrical shape are treated by perturbation theory, a procedure which is consistent with the usual series expansion in powers of reciprocal aspect ratio. The formalism provides analytic expressions for the auxiliary currents necessary to produce equilibrium in toroidal theta pinch systems such as Scyllac. (auth)

1267 (LA-3770, Paper B7) Z-DEPENDENT MARGINAL STABILITY OF THE RIGID-ROTOR MODEL OF A HIGH-BETA THETA PINCH. Freidberg, J. P.; Morse, R. L. (Los Alamos Scientific Lab., N. Mex.). 7p.

Dimensional equilibria in a cylindrical geometry are found for an infinitely long high-β theta pinch. The solutions are obtained by calculating a current using a rigid rotor distribution function (which is an exact solution to the Vlasov equation), and then solving self-consistently with Ampere's law. It is found, that for a given set of parameters which describe the plasma there exist two solutions to the equations. Solution I corresponds to the case of a monotonically decreasing density with radius, while Solution II describes a density which first rises and then decreases monotonically. A z-dependent marginal stability analysis of these two solutions indicates the following: (1) no z-dependent marginal states exist for Solution I; (2) a z-dependent marginal state exists for $k_z = 0$ for the special case in which Solutions I and II coalesce; (3) for Solution II a marginal, z-dependent state exists for some specific value of $k_z^2 > 0$, denoted by k_m^2. This indicates that Solution II is not a satisfactory equilibrium. Estimates of unstable growth rates will be given for $k_m^2 > k_z^2 > 0$. Comparison will be made with numerical simulation. (auth)

1268 (LA-3770, Paper F3) SHEATH STABILITY. Morse, R. L. (Los Alamos Scientific Lab., N. Mex.). 3p.

A class of finite-β marginally stable modes is considered, which are related to plasma density gradients. Perturbed currents and fields are calculated for a sheet pinch confined by a magnetic field which has the same sign on both sides of the plasma. The numerical simulation of mirror instabilities in θ-pinch plasmas and the resultant increase in thermal motion along field lines are considered. (auth)

1269 (LA-3770, Paper G6) HARD-CORE THETA PINCH AND ITS TOROIDAL EQUILIBRIUM. Yoshikawa, S. (Princeton Univ., N. J. Plasma Physics Lab.). 4p.

A hard-core theta pinch should have an advantage for confinement over an ordinary inverse theta pinch in that the plasma is stable against the overall macroscopic instability. The equilibrium

and overall stability of this plasma are considered using the well-known equilibrium equation. Estimates are made of the critical β for the finite-β ballooning instability. (auth)

1270 (ORO–2454-9) INSTABILITIES AND TURBULENCE IN ALKALI VAPOR PLASMAS. Progress Report, November 1, 1966–October 31, 1967. Robertson, Harry S. (Miami Univ., Coral Gables, Fla. Dept. of Physics). Contract AT(40-1)-2454. 12p. Dep. CFSTI.

Progress is described in the experimental and theoretical study of helical instabilities in minimum-B and uniform axial field geometry in a cesium arc plasma, experimental and theoretical studies of electrodeless rf-excited plasmas in magnetic fields, a general study of plasma diffusion as a boundary value problem, and a theoretical study of the diffusion of magnetized plasma filaments as a model for plasma turbulent diffusion. A reprint of the first publication on filamentary diffusion is attached. (auth)

1271 (RISO–158) THE EFFECT OF THE FINITE ION LARMOR RADIUS ON THE KELVIN–HELMHOLTZ INSTABILITY. Melchior, Henning; Popovic, M. (Danish Atomic Energy Commission, Risoe. Research Establishment). July 1967. 13p. Dep.

Excitation of the Kelvin–Helmholtz instability has been observed in a Q-machine when a sufficiently large velocity shear exists between adjacent layers of the plasma column. In an interpretation of this observation, possible effects of the finite ion Larmor radius and the collisional viscosity have been neglected. It is attempted to remove the first of these simplifications. With the finite ion Larmor radius included, the growth rate of the instability is computed for several values of the velocity shear and different e-folding lengths of the density profiles. (auth) (UK)

1272 (SU-IPR–198) STUDIES OF PLASMA OSCILLATIONS. Status Report No. 30, March 1–July 31, 1967. Crawford, F. W. (Stanford Univ., Calif. Inst. for Plasma Research). Sept. 1967. Contract AT(04-3)-326. 41p. Dep. CFSTI.

Research in the following areas is discussed: ion wave propagation and positive column instabilities, Langmuir probes in collisional plasma, cyclotron echoes, pulse technique for determination of collisional data, cyclotron harmonic wave phenomena, and beam/plasma interactions. (M.O.W.)

1273 STABILITY OF THE THETA PINCH. II. Haas, F. A.; Wesson, J. A. (United Kingdom Atomic Energy Authority, Culham, Eng.). Phys. Fluids, 10: 2245-52(Oct. 1967).

In a previous paper [F. A. Haas and J. A. Wesson, Phys. Fluids 9, 2472 (1966)] the hydromagnetic stability of a $\beta = 1$ theta-pinch with a sharp boundary was considered. This work is here extended to a study of $\beta < 1$. Stability criteria are obtained and in particular it is shown that the $m = 1$ mode is stable if $(1 - \beta) < (R/R_w)^2$ everywhere along the pinch, where R and R_w are the radii of the plasma and conducting wall, respectively. The case of a distributed radial pressure gradient is also considered. (auth)

1274 LARGE AMPLITUDE STABILIZATION OF FLUTE GROWTH. Byers, J. A. (Univ. of California, Berkeley). Phys. Fluids, 10: 2235-44(Oct. 1967).

Numerical results show that finite amplitude oscillatory but stable flutes can result from exponentially growing flutes which are excited at small amplitudes. The case examined here is an unstable flute in the low-density regime where the flute smearing due to the ion precessional drifts is almost sufficient to produce linear regime stability. The mechanism of nonlinear stabilization can be explained by a plausible extension of the marginal stability condition obtained by linear analysis. That is, at finite amplitude, the basic growth mechanism is reduced by nonlinear effects so that the previously weaker competing process (the change of phase of the charge distribution due to the ion precessional drifts) becomes the stronger mechanism. Total disruption of the basic growth mechanism is not required. One application is that experimental observation of the onset of instability may occur well into the unstable regime predicted by linear analysis, and may thus affect the interpretation of experimental results. (auth)

1275 NONLINEAR LIMIT OF A DRIFT INSTABILITY RELATED TO AURORAL BOMBARDMENT. Krall, Nicholas A. (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Phys. Fluids, 10: 2263-70(Oct. 1967).

The nonlinear development of the low-frequency transverse-drift instability is calculated. Although quasi-linear theory might be expected to be valid for such a mode, wave scattering is required to saturate the mode spectrum. The effect of the fully developed instability is a coordinate displacement, and a shift in $\bar{v}_z$. If applied to the radiation belts, this instability would predict auroral bombardment localized in radius, occurring in the lower density large-gradient regions of the particle distribution. (auth)

1276 HYDROMAGNETIC KELVIN INSTABILITY IN THE PRESENCE OF NEUTRAL PARTICLES. Rao, S. S.; Kalra, G. L. (Univ. of Delhi). Can. J. Phys., 45: 2779-85(Aug. 1967).

The stability of a tangential discontinuity in velocity in a plasma mixed with cold neutral particles is investigated in the presence of a uniform magnetic field. It is found that the effect of collisions between the plasma and the neutral particles is stabilizing or destabilizing according as ν, the collision frequency, is less than or greater than the parameter kc, where k is the wave number of the perturbation and c is the speed of sound for the plasma. (auth) (Canada)

1277 CORRELATION STUDY OF A DRIFT WAVE INSTABILITY. Chung, K.; Rose, D. J. (Massachusetts Inst. of Tech., Cambridge). Appl. Phys. Lett., 11: 247-8(Oct. 15, 1967).

A drift wave instability in a fairly highly ionized (50 to 90%) plasma column was observed and its properties readily determined using real time auto- and cross-correlation techniques. (auth)

1278 ION CYCLOTRON INSTABILITIES IN AN INHOMOGENEOUS PLASMA. Farr, William Morris. Ann Arbor, Mich., Univ. of Michigan, 1966. 127p.

Thesis.

A general dispersion equation for the propagation of electromagnetic perturbations in inhomogeneous, anisotropic plasma in a magnetic field is derived and analyzed for stability. For electrostatic modes with frequency near integral multiples of the ion cyclotron frequency propagating at arbitrary angles to the magnetic field and the direction of inhomogeneity, stability criteria are obtained depicting the effects of density gradients, field curvature, and various ion velocity distributions. It is found that higher order density gradient effects are significant only in the short (compared to the ion Larmor radius) wavelength limit and that in general it is sufficient to consider density gradients to lowest order only. For modes propagating normal to both the magnetic field and the density gradient a stability criterion relating field curvature and density gradients is obtained where it is shown that such modes can be unstable in mirror-type field configurations. In a plasma with a cold ion specie in addition to the hot components a previously obtained stability criterion for homogeneous plasma is modified to include spatial variations in plasma density and it is shown that the inhomogeneity has an adverse effect in the case of outward propagation from a cylindrical plasma. (Disser. Abstr.)

Thermonuclear Processes

1279 (LA–3770, Paper C2) DYNAMICS AND NEUTRON EMISSION OF A PLASMA FOCUS EXPERIMENT. Patou, C.; Simonnet, A.; Watteau, J. P. (Commissariat a l'Energie Atomique, Paris (France)). 6p.

A coaxial non cylindrical discharge is produced. The snow-plow model was used to study the dynamics of the discharge in its two phases: axial acceleration followed by a radial compression in front of the inner electrode. The mass accelerated in the first phase is not dragged along in the radial compression which occurs at peak current. The efficiency of the heating is due to the small mass of plasma which is compressed in the second phase. The stored magnetic energy is partially transferred to the plasma at the end of the compression and the measured neutron yield seems to increase with the part of the magnetic energy transferred. A study of the neutron yield was done on two hundred shots with the following experimental conditions = 18-kV voltage, 15-kJ energy, 500-kA peak electrical current, 3.3 torr total filling pressure. Experiments were made either with pure deuterium or with a 50/50 mixture of deuterium and tritium. With pure deuterium the average yield is 1.4×10^9 neutrons. It is half when adding 0.6% xenon, while the dispersion is three times smaller. With deuterium and tritium the neutron yield is approximately thirty times larger. The neutron durations are 80 ns with deuterium and 40 ns with deuterium and tritium. (auth)

1280 (LA–3770, Paper C3) PRODUCTION OF NEUTRONS BY A NONCYLINDRICAL Z PINCH. Coudeville, A.; Jolas, A.; Watteau, J. P. (Commissariat a l'Energie Atomique, Paris (France)). 6p.

To gather the plasma of a z pinch a noncylindrical insulator shape was used. The pyrex chamber has two symmetrical narrowings where the pinch effect develops more rapidly. In order to explain the discharge dynamics a two dimensions snowplough model was developed. The system of momentum and electrical equations was solved with calculations performed on computers. To check the validity of the model the shape of the plasma column and the current are compared with experimental data from framing pictures and electrical measurements. A comparison can be made with other noncylindrical discharges like those studied by FILIPOV

and MATHER. With a 1-torr deuterium pressure and an energy of 3 kJ, when the current reaches 100 kA a fast and strong decrease of the current deviative together with a simultaneous pulse of up to 5×10^6 neutrons are observed. Tentative explanations are proposed. (auth)

1281 (LA-3770, Paper C6) NEUTRON AND X-RAY PRODUCTION IN A FOCUSED Z PINCH. Meskan, David Allan; van Paassen, H. L.; Comisar, G. G. (Aerospace Corp., El Segundo, Calif.). 7p.

Diagnostic studies were made of the neutrons and x rays produced by a paraboloidal-geometry z-pinch device (700 m torr D_2, 15 kJ). The neutron energy spectra at 0 and 180° relative to the electric field applied at the pinch axis were obtained by nuclear emulsion techniques; they resemble the spectra obtained for linear pinches. The energy anisotropy can be explained in terms of a 90- to 130-keV deuteron beam that strikes stationary deuterons. Ross filters reveal complex x-ray spectra from 7 to 88 keV, while absorber studies reveal x radiation up to 350 keV. The spectrum from 7.11 to 29.2 keV is insensitive to neutron yield and fits the function $\omega^{-1.7}$, as does plasma bremsstrahlung from the electron energy distribution $E^{-2.2}$. The relationship between the power-law spectrum and MHD current turbulence theories is discussed. An x-ray tube spectrum typical of a copper anode bombarded by a 30- to 50-keV electron beam is superimposed on the continuum. The presence of energetic x rays and fast deuterons is not consistent with the boiler model of neutron production recently proposed by the Fillipovs. (auth)

Solid State Plasma

1282 (LA-3770, Paper H5) PULSED HIGH-DENSITY ELECTRON-HOLE PLASMAS IN THE LINEAR PINCH. Chen, Wen Shuh; Ancker-Johnson, Betsy (Boeing Scientific Research Labs., Seattle, Wash. Washington Univ., Seattle). 4p.

A new diagnostic instrument has been built which makes possible determining the density distribution of nonequilibrium plasma within the bulk of indium antimonide to a high degree of temporal and spatial resolution. The diagnostic tool consists of a N_2-CO_2 CW laser, a Cu-doped germanium detector, and associated electronic apparatus. The absorption of the infrared by the plasma is proportional to the plasma density, since the wavelength of the radiation, 10.6 μ, falls between the absorption edge in InSb, ~6 μ, and its lattice absorption cutoff, ~18 μ. The small spatial resolution is achieved by making the diameter of the probing infrared beam very small (dia. ≤0.15 mm). The good temporal resolution (tens of nanoseconds) is possible both because the detector has a fast response and because sampling techniques may be used since conditions in the plasma are highly reproduced from pulse to pulse. Measurements show the buildup of the pinch from an essentially uniform density distribution at early times to a highly peaked distribution at later times, while the applied power is held constant. The smallest pinch radii at the modest power levels so far employed are 0.05 mm, which corresponds to plasma density of $\sim 3 \times 10^{18}$ cm^{-3}. (auth)

1283 HELICON-WAVE PROPAGATION IN InSb. Burke, B. E.; Kino, G. S. (Stanford Univ., Calif.). J. Appl. Phys., 38: 4888-92(Nov. 1967).

Measurements have been made of the phase velocity and attenuation of helicon waves at microwave frequencies propagated along cylindrical samples of InSb at 77°K. Two of the modes of propagation (m = 0 and m = 1) were studied in two different samples. Experimental results are compared to a theory of Klozenberg et al., which takes into account the vacuum fields of the wave. Phase-velocity measurements are in good agreement with theory, but attenuation results are in some cases substantially lower due, in part, to displacement current effects neglected in the theory. No effects were observed when the electrons were subject to a pulsed drift field. (auth)

1284 THEORY OF WAVE PROPAGATION IN SOLID-STATE PLASMA WAVEGUIDES IN A DIRECTION NORMAL TO THE MAGNETIC FIELD. Wauer, D. (Heinrich-Hertz-Institut fuer Schwingungsforschung, Berlin). Hochfrequenztech. Elektroakust., 75: 185-8(Oct. 1966). (In German).

A discussion is presented of the wave propagation normal to an external field for a rectangular waveguide filled with a solid-state plasma. The wave equations for the electric and magnetic field vectors in an infinite gyrotropic medium are obtained and used to derive a dispersion relation for plane waves. The relation shows that, in general, two unlike plane waves can propagate simultaneously in opposite direction. (IAA)

Shielding

1285 (ANL-7314) RESPONSE OF MONOENERGETIC GAMMA RAYS IN FINITE MEDIA. Snow, William J. (Argonne National Lab., Ill.). Apr. 1967. Contract W-31-109-eng-38. 32p. Dep. CFSTI.

The response parameters of monoenergetic gamma rays incident on various materials with finite geometries has been calculated on a CDC-3600 computer. The Monte Carlo technique was used to obtain the solution to this gamma-ray transport problem. The program permits calculations of various source geometries and detector shapes for incident gamma rays varying in energy from 5 keV to 12 MeV. Results are included for gamma rays normal to cylindrical germanium and silicon detectors. Also presented are the data representing the double and single escapes subsequent to positron annihilation occurring uniformly throughout the volume of the detector. (auth)

1286 (FOA-4-4320-23) A STUDY OF THE NEUTRON INDUCED GAMMA ACTIVITY IN Mn-CONTAINING STEEL AND THE REDUCTION OF THE GAMMA RADIATION BY BORON SHIELDING. Jansson, R.; Beckman, L. (Forsvarets Forskningsanstalt, Stockholm (Sweden)). Oct. 1967. 8p. Dep.

The neutron induced gamma activity in ^{55}Mn in steel was studied with 14 and 2.5 MeV neutrons entering a steel plate behind which a thermalizing medium was situated. The effect of a boron shield between the steel plate and the thermalizing medium was investigated. The boron shield reduces the induced activity by capture of the reflected slow neutrons. The induced activity in iron through the reaction ^{56}Fe(n,p)^{56}Mn, produced by 14 MeV neutrons, was also studied. (auth)

1287 (JINR-P9-3369) IZMERENIE FAKTORA KACHESTVA PROTONOV VYSOKIKH ENERGII V VODNOM FANTOME. (Measurements of the Quality Factor for High Energy Protons in the Water Phantom). Zel'chinskii, M.; Komochkov, M. M.; Sychev, B. S.; Cherevatenko, A. P. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy). 1967. 10p. (In Russian). Dep.

The depth distribution of the quality factor (QF) for high-energy protons is found experimentally. The measurements were made by use of the tissue-equivalent recombination chamber, moved along the axis of the cylindrical 80-liters phantom. Values of QF for protons with energy 660 and 260 MeV are 1.8 ± 0.3 and 1.2 ± 0.2, respectively, and vary with the depth very slightly, increasing only in the region of the end of primary proton range. (auth)

1288 (ORNL-4147) CALCULATIONS, USING THE ALBEDO CONCEPT, OF THERMAL-NEUTRON FLUXES, EPICADMIUM-NEUTRON FLUXES, AND FAST-NEUTRON DOSE RATES ALONG THE CENTER LINES OF SQUARE CONCRETE DUCTS: COMPARISON WITH EXPERIMENT. Maerker, R. E.; Muckenthaler, F. J. (Oak Ridge National Lab., Tenn.). Oct. 1967. Contract W-7405-eng-26. 75p. Dep. CFSTI.

Monte Carlo calculations that use the albedo concept and a particularly demanding source geometry and spectrum have been carried out to determine subcadmium- and epicadmium-neutron fluxes and fast-neutron dose rates along the center lines of one-, two-, and three-legged square concrete ducts open on the source end. Secondary gamma-ray dose rates arising from the capture of neutrons in the duct walls were also calculated. The calculations used previously reported albedo data that are differential in both the reflected angles and the reflected energy. A comparison of the calculated neutron fluxes and dose rates with those obtained in geometrically identical experiments conducted at the Tower Shielding Facility shows agreement generally within 25 percent through five orders of duct attenuation. The results thus place on a firm foundation the method of treating neutron transmission through large-sized ducts as a multiple-reflection phenomenon describable by the differential albedo properties of the walls. The conclusion is also reached that wall-capture gamma-ray dose rates arising from capture of thermal-neutrons and the dose from the thermal neutrons themselves (whether due to an epicadmium source or a subcadmium source) can comprise a very important part of the total absorbed dose rate in tissue at locations deep inside a multilegged duct. (auth)

1289 (WAPD-T-2057) HIGH-ORDER TRANSPORT RESULTS FOR GAMMA RAYS IN MULTILAMINAR GEOMETRY. Lois, L. (Bettis Atomic Power Lab., Pittsburgh, Pa.). Sept. 1967. Contract AT(11-1)-Gen-14. 10p. (CONF-671102-26). Dep. CFSTI.

From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill.

A digital computer program called LETO was written for γ-ray

transport calculations in multilaminar geometry. The program is based on a formulation for the solution of the Boltzmann transport equation, which employs the double range Legendre polynomial expansion of the flux to obtain a round-off free analytic solution for the single-region monoenergetic problem. Buildup factors for 1- and 3-MeV plane and point isotropic sources in Fe and Pb are given and compared with results from the moments method. Results for a 6-MeV plane isotropic source in Pb are compared with the moments method and with a P-3 spherical harmonics calculation by Lanning. Comparison is also made with the results of Monte Carlo calculations in an iron–water laminar array. The agreement obtained implies that LETO can successfully cope with alternating material regions. LETO can supply, in addition, pointwise energy deposition and angular distributions. (A.G.W.)

1290 SOME RATIONAL APPROXIMATIONS FOR THE EXPONENTIAL INTEGRAL FUNCTIONS E_n (n = 1,2,3,4). Makino, Kakuji (Tokyo Shibaura Electric Co. Ltd.). Nukleonia, 10: 157-8(Sept. 1967).

The exponential integral functions occur in the calculations of first-flight collision probabilities in slab geometry. It is worthwhile to prepare the approximations for these functions to save the calculation time as well as the storages of the computer. A list is presented. (M.O.W.)

Solid-State Physics

Refer also to abstracts 130, 764, 769, 770, 960, 994, 995, 1070, 1367, 1568, 1569, and 1619.

1291 (AERE-R-5479) MATHEMATICAL FORMULATION OF THE SCATTERING OF LONG WAVELENGTH NEUTRONS BY DEFECTS IN SOLIDS. Martin, D. G. (Atomic Energy Research Establishment, Harwell (England)). July 1967. 44p. Dep. CFSTI. UK 6s. 0d.

The basic equations relating to the scattering of long wavelength neutrons by defects are derived from first principles and results quoted which will be useful in a wide variety of experiments. Differential and total cross sections of both single crystals and polycrystalline material are considered and results for interstitials, vacancies, and impurity atoms in the form of both point defects and clusters are given. Both elements and compounds are considered; also the effect due to the neighbouring lattice atoms around defects being relaxed is discussed. Modifications to these results due to the following effects are considered: (a) defects which are also paramagnetic, (b) solids which, to a certain extent, scatter incoherently, and (c) the effect of lattice vibrations. (auth) (UK)

1292 (IA-1132) MOESSBAUER EFFECT STUDIES ON ^{83}Kr IN BROMIDE AND BROMATE CRYSTALS. Pasternak, M.; Sonnino, T. (Israel Atomic Energy Commission, Yavne. Soreq Nuclear Research Center). July 1967. 22p. Dep.

Moessbauer effect studies were performed using ^{83}Kr sources produced by the β^- decay of ^{83}Br in various bromine compounds. Experiments were done with LiBr, NaBr, KBr, CsBr, NH_4Br, $KBrO_3$ and Kr-β-hydroquinone sources at 90°K using a solid krypton absorber at 22°K. No isomer shift was observed for any of the sources indicating that the Kr outer configuration is not perturbed by the induced dipole interaction with its neighbors. No "KrO_3" species was detected as a result of the β^- decay of Br in $KBrO_3$. Broad and symmetric emission lines were observed for the Kr-hydroquinone, bromides, and bromate, the line width increasing in that order. This broadening is explained on the basis of the formation of a local distorted crystalline field, as a consequence of the internal conversion process of ^{83m}Kr. From the fact that a symmetric line is observed it has been concluded that at least two modes of distortion are formed in such a way so as to produce opposite signs in the electric field gradient. The Debye temperature calculated for the alkali bromide sources was found to be 60°K on the average, and for NH_4Br to be 90°K. The techniques of source preparation and of the krypton absorber deposition are described. (auth)

1293 (IAE-1280) K VLIYANIYU IZMENENIYA SILOVYKH POSTOYANNYKH NA SVOISTVA KRISTALLOV S PRIMESNYMI ATOMAMI. (The Influence of Variation of the Force Constants on the Properties of Crystals with Impurity Atoms). Zhernov, A. P.; Augst, G. R. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Moscow. Institut Atomnoi Energii). 1966. 22p. (In Russian). Dep.

An impure crystal theory is constructed with consideration of variation of the force constants. The investigation was conducted on the example of a simple cubic lattice with interaction of nearest neighbors. Simple expressions are presented for the local states, demonstrating directly that with sudden weakening of the force constants a quasi-local state can arise even for a light atom, and with sudden intensification, a local state even for a very heavy atom. Conditions also were obtained under which an admixture atom preferentially fluctuates in those states. It was found that the temperature course of the impurity part of the heat capacity undergoes substantial variations upon sudden variation of the force constants and therefore can serve as a criterion of the magnitude of that variation. Analytical results showed that the temperature course of the probability of Moessbauer effect on the impurity nucleus also is such a criterion. (JPRS)

1294 (IN-1125) MACS M: A PROGRAM FOR COMPUTING THE CRYSTAL DYNAMICAL MATRIX, PHONON DISPERSION RELATIONS, AND STRUCTURE FACTORS FOR NEUTRON INELASTIC SCATTERING. Noble, C.; Solbrig, A. W. Jr.; McMurry, H. L. (Idaho Nuclear Corp., Idaho Falls). Oct. 1967. Contract AT(10-1)-1230. 36p. Dep. CFSTI.

The FORTRAN IV program MACS M (PPCo 40* 0650) computes the dynamical matrix for the harmonic oscillations of a crystal, the eigenvalues and eigenvectors of this matrix, and the corresponding structure factors for coherent single-phonon scattering of neutrons. The calculation of the dynamical matrix is especially adapted to the use of a potential in valence coordinates, but the input allows use of a potential in Cartesian coordinates. Running times on an IBM 7040 (32K, batch processing) for calculating a dynamical matrix and solving the corresponding secular equation are about one minute for diamond (two atoms per primitive cell) and two minutes to three minutes for beryllium oxide (four atoms per primitive cell). (auth)

1295 (LA-3750) LATTICE DYNAMICS OF LITHIUM HYDRIDE. Verble, J. Larry (Los Alamos Scientific Lab., N. Mex.). July 1967. Contract W-7405-eng-36. 99p. Dep. CFSTI. Thesis.

Crystalline lithium hydride, with four electrons per primitive unit cell, has the simplest electronic configuration of all ionic crystals with the sodium chloride-type structure and thus represents an excellent test case for existing theories of lattice dynamics of these substances. Lattice vibrations in this system have been studied by measuring the phonon dispersion curves along the three high-symmetry directions in a single crystal of ^{7}LiD, using the techniques of coherent inelastic scattering of thermal neutrons. The isotopes ^{7}Li and D were chosen over normal Li and H because of their more favorable neutron cross sections. All measurements were taken at room temperature using a triple-axis neutron spectrometer operating in the constant $\vec{Q}$ mode. Uncertainties in the measured frequencies are estimated to be no greater than 3 to 5%. The transverse zone center frequency is in excellent agreement with the infrared absorption data. The experimental dispersion curves have been least-squares fitted to several versions of the point ion and shell models of lattice dynamics. A seven-parameter shell model, which considers first neighbor and second neighbor negative ion short-range interactions, allows for the negative ion to be polarizable, and uses a variable ionic charge, fits the data to within the experimental accuracy. The model indicates that the negative–negative ion interactions are about 7% of the positive–negative ion interactions. In addition, the bond in ^{7}LiD is found to be about 88% ionic, in good agreement with estimates obtained from electronegativity considerations. From the best-fit model, the dispersion curves of ^{7}LiH have been calculated assuming that the forces are identical to those for ^{7}LiD. To simplify the application of the various models and to aid in classifying the dispersion curve branches, group theory has been applied to the problem of lattice vibrations in the sodium chloride structure. (auth)

1296 (NYO-3474-3(App.)) COLOR CENTERS, ENERGY STORAGE, AND THERMOLUMINESCENCE IN LiF CRYSTALS. Progress Report, January 1–September 30, 1967. Johnson, N. M.; Christy, R. W. (Dartmouth Coll., Hanover, N. H.). Contract AT(30-1)-3474. 4p. Dep. CFSTI.

The major part of the work in the past year was directed toward a very detailed analysis of all the absorption bands which occur in thermoluminescent LiF, in the energy range of photon energy up to about 7 eV, and of the transformations among these bands induced by optical and thermal treatments. The results are briefly summarized. (W.D.M.)

1297 (NYO-3474-3(App.B)) COLOR CENTER TRANSFORMATIONS IN LiF:Mg. Mayhugh, Michael R. (Dartmouth Coll., Hanover, N. H.). Oct. 1967. Contract AT(30-1)-3474. 50p. Dep. CFSTI. Thesis.

A systematic study has been made of the changes in the color centers in LiF:Mg due to thermal and optical treatments. The radiation-induced absorption at low dose (about 5000 R) is shown to result from the F band at 250 nm and gaussian bands centered

roughly at 380, 310, 270, 225, 205, and 196 nm. The 310-nm absorption band consists of two overlapping bands, one of which results from trapped electrons. Absorption bands located at wavelengths shorter than 196 nm are likely. The band is found to be asymmetric, perhaps because of a prominent K band. An explanation of the effects due to annealing and optical bleaching is made in terms of a model assuming hole centers absorbing in the 310- to 380-nm region. An alternate model based on absorption due only to trapped electrons in the 310- to 380-nm region is found to also explain the data. (auth)

1298 (NYO-3474-4) COLOR CENTERS, ENERGY STORAGE, AND THERMOLUMINESCENCE IN LiF CRYSTALS. Three-Year Summary Report, January 1965–January 1968. Christy, R. W.; Johnson, N. M. (Dartmouth Coll., Hanover, N. H.). Oct. 1, 1967. Contract AT(30-1)-3474. 3p. Dep. CFSTI.

The goal of this study as originally stated was to understand the defect-chemical basis of the high-temperature thermoluminescence in dosimetry-grade lithium fluoride. A very brief summary of the results obtained from Jan. 1965 to Jan. 1968 is presented. (W.D.M.)

1299 (ORO-2839-13) VOLUME MAGNETOSTRICTION IN FERROMAGNETIC MATERIALS. Final Report. Pavlovic, Arthur S. (West Virginia Univ., Morgantown. Dept. of Physics). Sept. 30, 1967. Contract AT(40-1)-2839. 9p. Dep. CFSTI.

A brief summary is presented of work on the determination of the anisotropic magnetostriction constants, the forced anisotropic magnetostriction constants, and the forced volume magnetostriction for single crystals of Gd, Fe, Ni, Ni–Cu alloys, Co, and a Co–8% Fe alloy from 77°K to as high as 900°K (depending on the material) and in magnetic fields up to 21 kOe (depending on the material). Detailed results are reported in published and to-be-published papers; a list of these papers is included. (A.G.W.)

1300 ELECTRON BEAM EXPOSURE FOR SiO_2. Denda, Seiichi; Baba, Harutsune; Tarui, Yasuo. Denki Shikensho Iho, 31: No. 4, 550-6(1967). (In Japanese).

Thin SiO_2 films on Si crystal were exposed to an electron beam of 10^{-3} to 1 coulomb/cm^2, and the change in their dissolving rate with a weak etchant was measured. The etching rate of thermally grown SiO_2 increased, while that of decomposed SiO_2 formed from organic substances decreased by the electron bombardment. The damage could be annealed by heating the sample above 600°C. Planar diodes were fabricated by this process, and their characteristics were compared with those of planar diodes fabricated by the standard photoresist technique. The pattern resolution higher than 1 μ was achieved by using a wedge-shaped metal mask. The effect could be applied to preparation of SiO_2 diffusion masks for monolithic integrated circuits without using photoresist films which may limit the pattern resolution. (auth)

1301 ANNEALING OF HALL-MOBILITY CHANGES IN ELECTRON-IRRADIATED GERMANIUM. Jaworowski, A. (Univ., Warsaw, Poland); Merski, K.; Rzewuski, H.; Werner, Z. J. Appl. Phys., 38: 4745-8(Nov. 1967).

Annealing of Hall-mobility changes in n-type germanium irradiated with 1-MeV electrons at 85°K was investigated using an isochronal technique. Two annealing stages which have been reported earlier were confirmed and separated. One stage at above 100°K is connected with "contact" annealing, and a second one close to 140°K is caused by bulk annealing. The latter stage corresponds to the stage found already by J. C. Pigg for gamma irradiation. (auth)

1302 MOESSBAUER-EFFECT STUDY OF SOLID-SOLUTION AND PRECIPITATED Fe-RICH Fe–Mo ALLOYS. Marcus, H. L.; Fine, M. E.; Schwartz, L. H. (Northwestern Univ., Evanston, Ill.). J. Appl. Phys., 38: 4750-8(Nov. 1967).

A detailed study of the precipitation reaction in an Fe–6 at. % Mo alloy at 550° and 650°C was made using the Moessbauer effect and Young's modulus. Moessbauer spectra of Fe_2Mo, Fe_3Mo_2, and alloys of 2.5 and 20 at. % Mo were also obtained. The Moessbauer spectra of the Fe-base Mo solid solution were analyzed on the basis of a 14 near-neighbor model. The six peaks of the Fe spectrum in the alloy were broadened into six envelopes. These were analyzed as a superposition of three sets of peaks, one set each for Fe atoms with 0, 1, and 2 Mo atoms among the 14 near-neighbors giving in the as-quenched Fe–6 at. % Mo alloy hyperfine fields of –335 ± 1, –296 ± 1, and –255 ± 2 kOe and the isomer shifts relative to pure Fe of +0.01 ± 0.005, –0.02 ± 0.01 and –0.05 ± 0.02 mm/sec, respectively. The precipitation in the Fe–6 at. % Mo alloy at 650°C occurred by a one-step process while the 550°C aging sequence occurred by a two-stage reaction, first clustering of Mo and then precipitation. An activation of 59 kcal/mole and a rate exponent of 1.2 were determined from modulus and Moessbauer data suggesting diffusion-controlled growth of thin long platelets. The solvus composition C_s in the temperature range 650° to 870°C was found by quantitative analysis of the Moessbauer spectra to follow the empirical relation $C_s = \exp -(7400/RT)$ at. % Mo assuming the precipitate to be Fe_2Mo. A mass balance ruled out Fe_3Mo_2 (or Fe_7Mo_6). The Fe_2Mo precipitate was confirmed in the Fe–20 at. % Mo alloy by x-ray diffraction. (auth)

1303 NUCLEAR RELAXATION IN SOLID ^{3}He AT LOW TEMPERATURES. Hunt, E. R.; Richardson, R. C.; Thompson, J. R.; Guyer, R. A.; Meyer, Horst (Duke Univ., Durham, N. C.). Phys. Rev., 163: 181-5(Nov. 5, 1967).

Measurements were made of the nuclear relaxation time τ in the bcc phase of solid ^{3}He for temperatures between 0.3 and 0.04°K. The relaxation times were found to decrease when the size of the sample chamber was reduced. In the range $0.2 \gtrsim T \gtrsim 0.1$°K, τ is temperature-independent and inversely proportional to the exchange parameter J for our two smaller sample chambers. The relaxation is attributed to the single-phonon process occurring in the magnetically irregular region of the sample boundary; Zeeman and exchange energy in the bulk ^{3}He then diffuse to the boundary in the time τ. The diffusion, due to the exchange interaction, is temperature-independent. Below 0.1°K, τ increases mildly with temperature in the smallest chamber. The temperature dependence of τ below 0.1°K indicates a possible phonon bottleneck. An order-of-magnitude calculation shows that at about 0.2°K the rate at which the spin system puts energy into the lattice becomes comparable to the rate at which the lattice can transfer that energy to the bath. The results can be used to estimate the nuclear relaxation time in the millidegree region where the magnetic transition is expected. (auth)

1304 LUMINESCENT BEHAVIOR OF BISMUTH IN RARE-EARTH OXIDES. Datta, R. K. (General Electric Co., Cleveland). J. Electrochem. Soc., 114: 1137-42(Nov. 1967).

Activation of rare earth oxides by ions other than rare earths was successfully attempted. Bi^{3+} was incorporated in yttrium, gadolinium, and lanthanum oxides by solid-state reactions. Probably a charge-transfer mechanism involving bismuth and oxygen introduces an absorption band at about 3200 Å region. Under 3650 Å radiation R_2O_3 : Bi (R = Y, Gd, La) showed Bi^{3+} emission (blue) with a broad-band spectrum extending from 4500 to 6000 Å and peaking at 5000 Å. When incorporated in R_2O_3 : Eu phosphors, Bi^{3+} acted as a sensitizer for Eu^{3+} emission under 3650 Å radiation. Energy absorbed by the bismuth-oxygen component was transferred by a radiationless process to Eu^{3+} resulting in the final emission from excited Eu^{3+} ($^5D_0 \rightarrow {}^7F_2$). However, under 2537 Å radiation Bi^{3+} in R_2O_3 : Bi acted as a "killer." Among the three oxide matrices studied, the fluorescence of Bi was found to be most efficient in Y_2O_3 host. Reflectance, emission, and excitation spectra of the phosphors are discussed with special reference to Y_2O_3 : Bi and Y_2O_3 : Eu : Bi. (auth)

1305 CYCLOTRON RESONANCE IN MOLYBDENUM. Herrmann, R. (Humboldt-Univ., Berlin). Phys. Lett., 25A: 607-9(Oct. 23, 1967). (In German).

Cyclotron resonance was investigated in molybdenum. A series of resonances has been found and the corresponding effective masses have been determined. The anisotropy of the effective masses shows that the Fermi surfaces of molybdenum and tungsten are quite similar. (auth)

1306 ON THE ANALOGY OF RECOVERY OF fcc AND HEXAGONAL METALS AFTER LOW-TEMPERATURE IRRADIATION. Schumacher, D.; Nicoud, J. C.; Delaplace, J.; Hillairet, J. (Centre d'Etudes Nucleaires, Grenoble, France). Phys. Lett., 25A: 610-11(Oct. 23, 1967). (In French).

After low-temperature neutron and electron irradiation, the recovery of the electrical resistivity and the release of stored energy of beryllium shows a striking similarity to that of aluminum. The analogies and also several differences are compiled and discussed. (auth)

1307 ON A NEW METHOD OF OBSERVING DEFECTS ANNEALING IN CRYSTALS. Evdokimov, I. N.; Mashkova, E. S.; Molchanov, V. A. (Moscow State Univ.). Phys. Lett., 25A: 619-20(Oct. 23, 1967).

A simple convenient method based on the use of ion-impact phenomena is proposed for studying the kinetics of the annealing of defects. (auth)

1308 STAGE I_E RECOVERY IN IRRADIATED fcc METALS. Frank, W. (Max-Planck-Institut fuer Metallforschung, Stuttgart); Von Jan, R. Phys. Lett., 25A: 621-2(Oct. 23, 1967).

The differences in the recovery kinetics of stage I_E observed in irradiated fcc metals for low and high irradiation doses are accounted for in terms of the annealing and conversion of crowdions that are capable of migrating but interact with vacancies within a large volume. (A.G.W.)

1309 FIRST- AND SECOND-ORDER QUADRUPOLE EFFECTS IN DILUTE Cu–Pt ALLOY FOILS. Tompa, K.; Toth, F.; Janossy, A. (Central Research Inst. for Physics, Budapest). Phys. Lett., 25A: 587-8(Oct. 23, 1967).

The experimental wipeout numbers for the first- and second-order quadrupole effects of ^{63}Cu NMR in copper-rich Cu–Pt dilute alloys were found to be 2000 ± 120 and 50 ± 5 respectively. (auth)

1310 WAVE–PARTICLE DUALITY IN PROTON EMISSION AND REFLECTION FROM CRYSTALS. Torrens, I. McC.; Chadderton, L. T. (North American Aviation Science Center, Thousand Oaks, Calif.). Phys. Lett., 25A: 575-6(Oct. 23, 1967).

Computer simulation of the emission and reflection of low-energy protons from crystals yields the broad features seen in experiment. The existence of a wave mechanical description of the same phenomenon suggests a regime of correspondence for scattering by a periodic medium. (auth)

1311 LATTICE DYNAMICS OF SIMPLE HARMONIC AND ANHARMONIC SHELL MODELS. Oitmaa, J. (Univ. of New South Wales, Kensington, Australia). Aust. J. Phys., 20: 495-505(Oct. 1967).

The lattice dynamics of harmonic and anharmonic shell models are reviewed. It is shown that the various dynamical equations for the shell model can be expressed in the same form as those for the rigid ion model, but with modified force constants. The anharmonic shell model leads to higher order contributions to the dipole moment, quadratic and cubic in the normal coordinates, for which explicit expressions are obtained. (auth)

1312 STUDY OF SIMULTANEOUS REFLECTIONS AND OF THEIR INFLUENCE ON THE TRANSMISSIBILITY OF ELECTRONS ACCELERATED AT POTENTIALS OF BETWEEN 100 AND 1200 KILOVOLTS. Ayroles, Rene; Mazel, Annie (CNRS, Toulouse). J. Microscop., 6: 135-50(1967). (In French).

Absorption of electrons accelerated at energies up to 1.2 MeV by crystalline material was examined in relation to the observed reflections. Microdiffraction patterns from single crystals of MgO attached to tilting object holder allowed registration of reflections. They occurred for certain crystal orientations and generally yielded very intense spots. As the electron-accelerating voltage was increased, spots of higher and higher orders appeared and the simultaneous reflections thus became more and more numerous. Extinction distance and mean electron absorption coefficients were determined for voltages between 100 and 1200 kV. These experiments showed that simultaneous reflections led to anomalous values. If there were no such reflections, the results of the measurements were independent of crystal orientation. (BBB)

1313 DISLOCATIONS, SLIP, AND FRACTURE IN BeO SINGLE CRYSTALS. Bentle, G. G.; Miller, K. T. (Atomics International, Canoga Park, Calif.). J. Appl. Phys., 38: 4248-57(Oct. 1967).

Dislocations formed during the growth and deformation of BeO single crystals were studied with x-ray and electron microscopy. The stresses for slip on the systems (0001) $\langle 11\bar{2}0\rangle$, $\{10\bar{1}0\}$ [0001], $\{10\bar{1}0\}$ $\langle 11\bar{2}0\rangle$, and $\{11\bar{2}2\}$ $\langle 11\bar{2}3\rangle$ are approximately 3.5×10^8, 1.1×10^9, 4.9×10^8, and $>2.5 \times 10^9$ dyn/cm^2, respectively, at 1000°C. Slip directions in deformed specimens were shown with x-ray microscopy. Defects in the specimens were shown to interfere with slip. Dislocation pinning and elastic interactions were observed in electron micrographs. These observations are correlated with theory. (auth)

1314 SLIP MODES OF HEXAGONAL-CLOSE-PACKED METALS. Yoo, M. H.; Wei, C. T. (Michigan State Univ., East Lansing). J. Appl. Phys., 38: 4317-22(Oct. 1967).

The effective shear moduli, dislocation line energies, dislocation widths, and relative ease of gliding have been calculated for the (0001) [$11\bar{2}0$], ($1\bar{1}00$) [$11\bar{2}0$], ($1\bar{1}01$) [$11\bar{2}0$], ($11\bar{2}2$) [$11\bar{2}3$], and (hk.0) [0001] slip systems in each of the hexagonal close-packed metals Cd, Zn, Mg, Co, Zr, Ti, and Be by applying anisotropic elasticity theory of dislocations. Except for the case of Be, the results correctly explain the choice of prevailing slip systems among the three with a common slip vector $\frac{1}{3}$ [$11\bar{2}0$]. The second-order pyramidal slip, frequently observed in Cd and Zn, cannot be accounted for in terms of its calculated relative ease of gliding. It seems that the extended nature of a dislocation, hence the stacking-fault energy, may affect the ease of gliding of the dislocation. (auth)

1315 GAMMA-RADIATION-INDUCED THERMOLUMINESCENCE IN Pr^{3+}:LaF_3. Gravely, Ben T.; Cobb, G. C. (North Carolina State Univ., Raleigh). J. Appl. Phys., 38: 4548-9 (Oct. 1967).

Thermoluminescent emission from $^{3+}$Pr : LaF_3 after gamma radiation at low temperature, without further stimulation, is reported. The sample was cooled to approximately 100°K and irradiated to a total dose of 100,000 R in 37 min using ^{60}Co gamma rays. A series of thermoluminescent-glow curves covering the spectral peaks at 4862, 5227, and 5987 Å were made. The temperature range was –160°C to +100°C with a slit width of approximately 105 Å on the monochrometer. The maxima of these curves are listed with the temperatures at which they occurred. (M.H.R.)

1316 EFFECTS OF RADIOACTIVE ^{35}S IN ZnS CRYSTALS. Blount, George H.; Phipps, P. B. P.; Bube, Richard H. (Stanford Univ., Calif.). J. Appl. Phys., 38: 4550-2(Oct. 1967).

Sulfur 35 with a half-life of 87 days was used to introduce ^{35}Cl donors into ZnS. As the ^{35}Cl is generated (total concentration of 10^{13} cm^{-3}), no increase in dark conductivity is observed, but the blue "self-activated" photoluminescence band appears. The low energy of the beta rays produced by the decay of ^{35}S permits the radiation damage to be assessed, and a new model is proposed for the "self-activated" luminescence center. (M.H.R.)

1317 PHOTOLUMINESCENCE IN CdS ASSOCIATED WITH NITROGEN IMPURITIES. Nyberg, D. W.; Colbow, K. (Simon Fraser Univ., Burnaby, B. C.). Can. J. Phys., 45: 3333-7 (Oct. 1967).

In the photoluminescence spectrum of cadmium sulfide, new emission bands have been produced which can be attributed to nitrogen impurities giving rise to acceptor levels 131 MeV above the top of the valence band. (auth)

1318 DEFECT-CONCENTRATION DEPENDENCE OF ANNELAING RATE IN SILICON. Fang, P. H. (Goddard Space Flight Center, Greenbelt, Md.); Liu, Y. M. J. Appl. Phys., 38: 4552(Oct. 1967).

The dependence of the isothermal annealing rate of electron-bombardment-induced radiation defects in lithium-doped n-type silicon on the defect concentration is discussed and some physical interpretation of the results is given. (M.H.R.)

1319 SATELLITE STRUCTURE AND NMR SHIFT OF ^{195}Pt IN Pt–Mo ALLOYS. Weisman, I. D.; Knight, W. D. (Univ. of California, Berkeley). Phys. Lett., 25A: 546-7(Oct. 9, 1967).

The ^{195}Pt NMR shift decreases markedly in Pt with increasing Mo. A weakening of the exchange enhancement is discussed as a possible mechanism. (auth)

1320 EFFECT OF ALLOYING OF Ti, Y, Nb, AND Hf ON THE BAND FERROMAGNETISM IN $ZrZn_2$. Ogawa, S. (Electrotechnical Lab., Tokyo). Phys. Lett., 25A: 516-7(Oct. 9, 1967).

Magnetization measurements have been made on the ternary alloys $Zr_{1-x}M_xZn_2$, where M = Ti, Y, Nb, and Hf. The band ferromagnetism in $ZrZn_2$ has been remarkably affected by alloying. The rigid band model cannot account for the effect. (auth)

1321 THE SHORT-RANGE MAGNETIC ORDERING IN $RbNiF_3$ ABOVE THE CURIE POINT ACCORDING TO NMR DATA. Smolenskii, G. A.; Petrov, M. P.; Moskalev, V. V.; Kasperovich, V. S.; Jirnova, E. V. (Inst. of Semiconductors, Leningrad). Phys. Lett., 25A: 519-20(Oct. 9, 1967).

The temperature dependence of the nuclear magnetic resonance line shift (ΔH) has been investigated in single-crystal $RbNiF_3$. From these data conclusions about the existence of two oppositely directed magnetic sublattices and short-range magnetic ordering have been drawn. (auth)

1322 LOCAL MAGNETIC FIELD SHIFT IN NATURAL KRYPTON. Brinkmann, D. (Univ., Zurich). Phys. Lett., 25A: 520-1(Oct. 9, 1967).

The NMR local magnetic field shift of ^{83}Kr in natural krypton is measured. The results are compared with theoretical predictions. (auth)

1323 ANISOTROPY OF HOT ELECTRONS IN HIGH-RESISTIVITY SILICON: PRELIMINARY RESULTS. Alberigi Quaranta, A.; Martini, M.; Ottaviani, G.; Redaell, G.; Zanarini, G. (Univ. of Modena, Italy). Solid State Commun., 5: 747-9(Sept. 1967).

The first results are given of a new method for measuring the drift velocities of both electrons and holes in the same sample of high-resistivity silicon. The method consists of analysing the pulse obtained by the incidence of short-range ionizing particles (e.g., natural alpha particles) on both sides of Si totally depleted detectors (surface-barrier or diffused-type). The data presented were obtained at 300° and at 77°K for two orientations of the electric field in the crystal. (auth) (UK)

1324 ELECTRON NUCLEAR DOUBLE RESONANCE OF THE F CENTRE IN CaF_2. Hayes, W.; Stott, J. P. (Oxford Univ.). Proc. Roy. Soc. (London), Ser. A, 301: 313-26(1967).

Although much work has been done on colour centres in the alkaline earth fluorides, precise information on the structure of intrinsic point defects in these crystals is meagre. Arends (1964) reported an EPR spectrum in additively coloured CaF_2 which

he assigned to the F centre. The present authors carried out ENDOR measurements on additively coloured CaF_2 which confirm that the EPR spectrum described by Arends is indeed due to the F centre. The hyperfine interaction of the F centre electron with the nuclei of the first four fluorine shells centered on the F centre was measured and results compared with preliminary calculations of the hyperfine constants by Stoneham (private communication). The effects of fluorine–fluorine interaction on the ENDOR spectrum of the first shell fluorines were investigated in detail. (auth) (UK)

1325 PROXIMITY EFFECT OF A SUPERCONDUCTOR ON AN ANTIFERROMAGNETIC METAL. Tilley, D. R. (Mullard Research Labs., Redhill, Eng.). Phys. Kondens. Mater., 6: 236-42(1967).

There should be two contributions to the pair breaking energy in an antiferromagnetic metal. The first, already discussed by De Gennes and Sarma, is due to disorder on the magnetic sites. The second is a temperature dependent contribution from electron magnon scattering. This term is calculated for the temperature range $T_N(J/\mu)^2 \ll T \ll T_N$ and found to be of order T^2/T_N. (T_N = Néel temperature, μ = Fermi energy, J = exchange coupling between conduction electrons and magnetic ions.) (auth)

1326 OBSERVATION OF THE MOESSBAUER EFFECT WITH ^{57}Fe FOLLOWING NEUTRON CAPTURE IN ^{56}Fe. Berger, W. G. (Kernforschungszentrum, Karlsruhe, Ger.); Fink, J.; Obenshain, F. E. Phys. Lett., 25A: 466-8(Sept. 25, 1967). (ORNL-P-3234).

Moessbauer effect with ^{57}Fe following neutron capture in ^{56}Fe has been observed in metallic iron, Fe_2O_3, and $FeSO_4 \cdot 7H_2O$. (auth)

1327 RELATION BETWEEN TENSORS OF CONDUCTIVITY AND THERMOELECTRIC POWER IN A DEGENERATE ELECTRON GAS. Tavernier, J.; Calecki, D. (LCIE, Fontenay-aux-Roses, France). J. Phys. Chem. Solids, 28: 1388-9(July 1967).

An expression is given for the relation between the tensors of electrical conductivity and thermoelectric power in the absence of magnetic induction, and it is shown that in the presence of magnetic induction an analogous expression may be derived. (UK)

1328 OPTICAL PROPERTIES AND ELECTRON BAND STRUCTURE OF EUROPIUM AND BARIUM. Mueller, W. E. (IBM Forschungslaboratorium, Zurich). Phys. Kondens. Mater., 6: 243-68(1967). (In German).

Optical properties of the divalent rare earth metals europium and ytterbium, obtained by transmission and reflection measurements in the spectral range 0.3 to 4.0 eV at room temperature, demonstrate the close relation between these two metals and the alkaline earth metals, especially barium. The structure occurring in the real part of the conductivity $\sigma(\omega)$ could be assigned to optical interband transitions by means of recent energy band calculations for europium. The similarity of the experimental absorption curves of europium and barium suggests, in the spectral range considered, an almost identical band structure of the two metals and, moreover, no effect of the 4f-electrons of europium in the optical spectrum exists. (auth)

1329 EFFECT OF NEUTRON IRRADIATION ON THE MECHANICAL PROPERTIES OF MOLYBDENUM SINGLE CRYSTALS. Mikhailov, S. K.; Solomko, Yu. V.; Aleksandrov, S. I.; Golovchenko, Yu. M. Fiz. Metal. Metalloved., 23: 957-8(May 1967). (In Russian).

Defects in metals with a bcc lattice brought about by neutron irradiation can be eliminated by annealing at 0.07 to 0.45 melting temperature (T_m). At approximately 0.45 T_m (1300°C for molybdenum), the defects which cause the change in mechanical properties are eliminated. In this work, the effect of irradiation at temperatures above 0.45 T_m on the mechanical properties of molybdenum single crystals was investigated. The specimens (3 mm in diameter), after being electrolytically polished and annealed in a vacuum of 10^{-5} mm Hg at 1000°C for 2 hr, were irradiated at 1600°C with a neutron integral dose of 10^{20} n/cm^2 in the active reactor zone. Neutron irradiation at 1600°C did not strengthen the molybdenum single crystals, but did increase the ductility, especially at 150°C. (ATD)

1330 ELECTRON SPIN RESONANCE OF THE F CENTRE IN ZnS. Schneider, J. (Univ., Freiburg i. B.); Raeuber, A. Solid State Commun., 5: 779-81(Sept. 1967).

A characteristic ESR line at g = 2.0034 was observed in ZnS crystals annealed in liquid zinc. The same signal occurred in samples exposed to fast neutron irradiation or subjected to violent mechanical treatment. Hyperfine interaction of the unpaired electron with four equivalent ^{67}Zn nuclei could be detected. The paramagnetic defect observed is assigned to the F-center in ZnS, i.e., to a singly negatively charged sulphur vacancy. (auth) (UK)

1331 REACTIONS BETWEEN V AND F CENTRES IN KBr. Comins, J. D. (Univ. of Witwatersrand, Johannesburg). Solid State Commun., 5: 709-13(Sept. 1967).

The reactions between V and F centers formed by x-irradiation between 81 and 297°K were studied. The stability of these defects increases with increasing temperature of x irradiation. Experiments involving optical bleaching and re-irradiation with x rays provide evidence for vacancy–interstitial recombinations, which are correlated with changes in the F band and the V_4 band region. (auth) (UK)

1332 EFFECT OF LATTICE DISTORTION ON THE DEBYE–WALLER FACTOR. II. CRYSTAL SURFACES. Vail, J. (Univ. of Manitoba, Winnipeg). Can. J. Phys., 45: 2661-70 (Aug. 1967).

The lattice distortion which occurs at the surface of a monatomic metal is investigated by considering a simple cubic model based on a Morse potential interaction between pairs of atoms. Effective nearest-neighbor harmonic coupling constants are estimated for the following cases: (a) an atom in an infinite monatomic cubic crystal; (b) an atom in the surface layer of a semi-infinite monatomic cubic crystal, taking account of lattice distortion, and considering vibrations both parallel and perpendicular to the surface; and (c) an atom on the surface, vibrating perpendicular to the surface. From these results the relative magnitudes of the Debye–Waller factor are estimated for the various cases. It is found that this model, in contrast to purely harmonic-force models, has the Debye–Waller factor for vibrations parallel to the surface greater than the bulk value. Also, comparison with the results of other models suggests that surface lattice distortion reduces the Debye–Waller factor from the bulk value by about as much as does the creation of a surface itself, ignoring the attendant lattice distortion. (auth)

1333 EFFECT OF LATTICE DISTORTION ON THE DEBYE–WALLER FACTOR. I. EXTENDED INTERNAL DEFECTS. Vail, J. (Univ. of Manitoba, Winnipeg. Univ. of Wisconsin, Madison). Can. J. Phys., 45: 2651-60(Aug. 1967).

A model is introduced in which a Moessbauer atom in an extended internal defect is replaced by a point defect in a perfect lattice, with coupling equal to that in the extended defect. Lattice distortions are considered which are typical for extended defects, with 5 and 10% dilatation and compression, effective coupling constants in nearest-neighbor harmonic approximation are estimated for these cases for a monatomic cubic crystal with Morse potential interaction, and Visscher's data are then used to estimate the fractional change in the Debye–Waller factor, e^{-2W}. Decreases of 14 and 38% are found in e^{-2W} for 5 and 10%, respectively, of lattice dilatation in extended defects, using parameters that are typical of monatomic metals. (auth)

1334 NUCLEAR SPIN–LATTICE RELAXATION TIME MEASUREMENTS FOR IMPURITIES IN FERROMAGNETIC ALLOYS BY NUCLEAR ORIENTATION. Reid, P. G. E.; Sott, M.; Stone, N. J. (Clarendon Lab., Oxford). Phys. Lett., 25A: 456-7(Sept. 25, 1967).

By observation of the growth of gamma-ray anisotropy upon magnetic polarization of dilute alloys of ^{198}Au, ^{60}Co, ^{192}Ir and ^{125}Sb in iron, cooled to temperatures in the range 0.1 to 0.01°K, the nuclear spin–lattice relaxation times of these nuclei have been measured. (auth)

1335 PHENOMENOLOGICAL MODEL FOR THE NEW EFFECT IN DYNAMIC POLARIZATION. Hwang, Chester F.; Hill, Daniel A. (Northwestern Univ., Evanston, Ill.). Phys. Rev. Lett., 19: 1011-14(Oct. 30, 1967).

A phenomenological model involving the cross-coupling of the allowed and forbidden EPR transitions between electrons belonging to neighboring packets of an inhomogeneously broadened EPR spectrum is proposed. This model yields all the observed qualitative features of the new effect in dynamic polarization previously reported. (auth)

1336 HIGHLY SPIN-POLARIZED PROTON SAMPLES: LARGE, ACCESSIBLE, AND SIMPLY PRODUCED. Honig, A. (Syracuse Univ., N. Y.). Phys. Rev. Lett., 19: 1009-10(Oct. 30, 1967).

In the proposed system for providing polarized protons for targets, a sample of solid HD with about 1% normal-H_2 impurity is used. The sample is polarized at 0.005°K and 100 kOe and left standing under these conditions for two months during which time ortho-H_2 converts to para-H_2. The spin–lattice relaxation time of the para-H_2 is long enough that the solid HD can then be transferred to ordinary liquid-helium-cooled Dewars in weak magnetic fields without significant loss of proton polarization. The possibility of polarizing the deuteron also is considered. (A.G.W.)

1337 CONDUCTION-ELECTRON CONTRIBUTIONS TO THE HYPERFINE FIELDS IN METALLIC Eu AND Gd. Hufner, S. (Bell Telephone Labs., Murray Hill, N. J.). Phys. Rev. Lett., 19: 1034-7(Oct. 30, 1967).

The Mössbauer effect of the 21.7-keV γ line of ^{151}Eu has been employed to study the isomer shifts and the magnetic fields in Eu–Yb alloys. From these measurements the conduction-electron contribution to the hyperfine field at the Eu atom in Eu metal due to its own 4f electrons and due to its neighboring atoms can be deduced. In addition an explanation is given for the apparent lack of conduction-electron contribution to the observed hyperfine field in metallic Gd. (auth)

1338 OPTICAL AND PHOTOELECTRIC PROPERTIES OF THE F CENTRE IN ZnS. Leutwein, K. (Institut fuer Elektrowerkstoffe, Freiburg i. B.); Raueber, A.; Schneider, J. Solid State Commun., 5: 783-6(Sept. 1967).

The optical absorption spectrum of additively coloured ZnS crystals was found to arise from two different types of colour centres. One centre causes absorption at 0.355 μm. Its structure is unknown. The remaining two absorption bands at 0.430 μm and 0.545 μm are tentatively assigned to the F centre in ZnS, i.e., a singly negatively charged sulphur vacancy. Photoconductivity and the optical response of the ESR signal of the F centre were also investigated. Near-infrared fluorescence was observed in additively coloured ZnS. (auth)

1339 CRYSTAL WAFER ORIENTATION BY PROTON CHANNELLING. Dearnaley, G.; Wilkins, M. A. (Atomic Energy Research Establishment, Harwell, Eng.). J. Sci. Instrum., 44: 880-1(Oct. 1967).

Proton channelling has been utilized to achieve very precise orientation of silicon wafers, of thickness up to 0.5 mm, with an accuracy to 0.02°. (auth)

1340 ELECTRON SPIN RESONANCE OF COLOURED $NaClO_3$. Ramasastry, C.; Sastry, S. B. S. (Indian Inst. of Tech., Madras). Solid State Commun., 5: 799-801(Oct. 1967).

The results of electron spin resonance studies of colour centres in powders of x-irradiated $NaClO_3$ crystals before and after thermal bleach are reported and compared with those for single crystals. The spectrum of the powder is much simplified, and the g-values and half widths for different peaks were obtained after separating them by a graphical analysis. (auth)

1341 HYPERFINE FIELD OF ^{197}Au IN FERROMAGNETIC Au_4V. Dunlap, B. D.; Darby, J. B. Jr.; Kimball, C. W. (Argonne National Lab., Ill.). Phys. Lett., 25A: 431-2(Sept. 25, 1967).

The temperature dependence of the Moessbauer resonance of ^{197}Au in ferromagnetic Au_4V has been investigated. Below the Curie temperature, the magnetic hyperfine interaction gives rise to line broadening. The magnitude of the effective field indicates that the magnetic moment in Au_4V is localized on the V atoms and little moment, if any, resides on the Au. The temperature dependence of the hyperfine field is observed to approximately follow the bulk magnetization. (auth)

1342 MOESSBAUER EFFECT AT ^{119}Sn IN AuMn, AgMn, CuMn, AND AuFe ALLOYS. Jain, A. P.; Cranshaw, T. E. (United Kingdom Atomic Energy Research Establishment, Harwell, Eng.). Phys. Lett., 25A: 425-7(Sept. 25, 1967).

Moessbauer studies of the hyperfine field at ^{119}Sn in binary CuMn, AgMn, AuMn, and AuFe are reported. The interpretation of the data in terms of a Poisson distribution of fields suggests a long range of conduction electron polarization. (TSS)

1343 SOME PROPERTIES OF TITANO–MAGNESIUM AND TITANO–BERYLLIUM OXIDE ENERGY ABSORBERS OF SUPERHIGH-FREQUENCY VIBRATIONS AND THE EFFECT OF ELECTRON BOMBARDMENT ON THEIR SUBSTANCE. Mikhailov, G. S.; Lysova, L. A.; Akimovich, I. N. (Inst. of Radiophysics and Electronics, Kharkov). Ukr. Fiz. Zh., 12: 1414-24(Sept. 1967). (In Russian).

The investigation of the physical properties of substances which may be used for creating energy absorbers of superhigh-frequency vibrations, capable of working under conditions of intense electron bombardment and high temperature in vacuum, is of great importance for the further improvement of powerful generators of amplifiers of superhigh-frequency vibrations of the type of traveling-wave tube, reverse wave tube, etc. The results are presented of an experimental study of energy absorbers of superhigh-frequency vibrations which were synthesized on the basis of beryllium and titanium, and magnesium and titanium oxides. It was found that such absorbers are suitable for use in vacuum instruments with a millimeter range under conditions of intense electron bombardment. An intense getterizing effect of titano–magnesium absorbers was discovered during their pulverization in vacuum under the effect of electronic bombardment. (auth)

1344 EFFECT OF OXYGEN-CONTAINING IMPURITIES AND X-RAY RADIATION ON THE ABSOLUTE QUANTUM YIELD AND STRUCTURE OF THE SPECTRA OF PHOTOLUMINESCENCE EXCITATION OF NaI:Tl CRYSTALS. Vishnevskii, V. N.; Pidzyrailo, N. S. (Lvov State Univ.). Ukr. Fiz. Zh., 12: 1466-73(Sept. 1967). (In Russian).

The effect was studied of oxygen-containing impurities and x radiation on the absolute quantum yield and structure of the spectra of photoluminescence excitation of NaI:Tl crystals. Introduction of the impurities OH^-, NO_3^-, NO_2^-, CO_3^{2-}, SO_4^{2-} into NaI:Tl crystals leads to a decrease in the absolute quantum yield of photoluminescence by a factor of two and more. Univalent impurities are most active in luminescence quenching, bivalent ones are considerably weaker. The effect of these impurities is different on high-energy and low-energy excitation bands of Tl^+ centers. The presence of oxygen-containing impurities essentially affects the temperature dependence of the quantum yield. X irradiation of the crystals at 100°K results in the decrease of the absorption and intensity coefficients of the excitation bands of Tl^+ centers as well as in the appearing of Tl^0 centers. Heating crystals up to 320°K or their infrared illumination restores the concentration of Tl^+ centers. Possible mechanisms of these processes are discussed. (auth)

1345 PARAMAGNETIC-RESONANCE STUDY OF CRYSTAL-FIELD AND EXCHANGE EFFECTS IN AN EXCITED STATE OF TmN. Cooper, Bernard R. (General Electric Research and Development Center, Schenectady, N. Y.); Fedder, R. C.; Schumacher, D. P. Phys. Rev., 163: 506-17(Nov. 10, 1967).

Paramagnetic resonance has been observed in an excited Γ_5 triplet state 222°K above the singlet Γ_1 ground state of Tm^{3+} ($4f^{12}$) in cubic TmN (i.e., pure compound concentrated in Tm^{3+}). The g factor has a small temperature dependence that has been interpreted as a shift, caused by ferromagnetic exchange, from the crystal-field only value. For exchange small compared to crystal-field effects, theory predicts a g shift proportional to a quantity differing only slightly from the susceptibility, i.e., going approximately as 1/T for the temperature range of interest. The over-all trend of the g temperature dependence is consistent with this for small ferromagnetic exchange; however, there is an anomalous minimum in the g temperature dependence centered about 120°K. The intensity reaches its maximum and the linewidth a minimum near the same temperature. The analysis of the behavior of g, ignoring the anomaly, gives the values $x = -0.990$, $W = -3.47$°K for the crystal-field parameters, and $\mathcal{J}(0)J(J+1) \equiv J(J+1)\,\Sigma_j \mathcal{J}_{ij} = 11.4$°K for the exchange energy per ion. These crystal-field parameters give a calculated temperature dependence of the resonant intensity in quite good agreement with experiment. (auth)

1346 GENERAL THEORY OF TUNNELING IN OXIDE DIODES. Zawadowski, A. (Central Research Inst. for Physics, Budapest). Phys. Rev., 163: 341-51(Nov. 10, 1967).

The well-known theory of tunneling in oxide diodes is the tunneling-Hamiltonian method, but this cannot describe processes happening in the oxide layer. Some new experiments necessitate the treatment of the electrons in the barrier as well. A method was elaborated using Green's functions to describe the whole phenomenon in an iterative procedure. The starting point is the treatment of two other problems where the metal on the left or right side of the barrier is replaced by an insulator. The current density in the barrier has been derived for normal and superconducting junctions. The phenomenon in a magnetic field has been treated using the microscopic theory, avoiding phenomenological considerations. The applicability of the tunneling Hamiltonian has been investigated; by its use the total current may be calculated. This method has proved to be very suitable for the problem of the anomalous tunneling between two normal metals with paramagnetic impurities in the barrier. (auth)

1347 NUCLEAR-MAGNETIC-RESONANCE SPIN ECHOES IN ALLOYS. Alloul, H.; Froidevaux, C. (Faculte des Sciences, Orsay, France). Phys. Rev., 163: 324-34(Nov. 10, 1967).

In disordered alloys, the Knight shift and the quadrupolar coupling vary from one nuclear site to the next. These variations have a strong influence on the shape of the spin-echo envelope of a given nuclear spin species. A general calculation has been developed involving 90°-180° pulse sequences. Two types of modulation of the spin-echo envelope are predicted under certain conditions. The first is related to quadrupolar effects, the second to spin-spin interactions. Experiments on ^{207}Pb ($I = 1/2$) have been performed at liquid-helium temperature in various lead solid solutions. The shape of the experimental echo envelopes agrees with the theoretical predictions. In particular, there is no depen-

dence of the modulation period on the nature of the solute or on its concentration. The value of this period ($2\tau_M = 305 \pm 15$ μ sec) together with the exchange-narrowed linewidth in pure Pb metal is used to determine the indirect spin-spin-interaction coupling constants. The values of these coupling constants between first-nearest neighbors are, respectively, $J/2\pi = 4.8$ kHz for the indirect exchange and $b/2\pi = 2.2$ kHz for the pseudodipolar interaction. Similar results are analyzed for platinum. An attempt is made to interpret the results in terms of the band structure. (auth)

1348 MOESSBAUER EFFECT IN ^{193}Ir IN INTERMETALLIC COMPOUNDS AND SALTS OF IRIDIUM. Atzmony, U. (Hebrew Univ., Jerusalem); Bauminger, E. R.; Lebenbaum, D.; Mustachi, A.; Ofer, S.; Wernick, J. H. Phys. Rev., 163: 314-23(Nov. 10, 1967).

Recoilless-absorption measurements of the 73-keV γ rays of ^{193}Ir have been carried out using an ^{193}Os source in metallic form and absorbers of Ir metal, $Fe_{0.99}Ir_{0.01}$, various rare earth–iridium (RIr_2) intermetallic compounds, and a few trivalent and tetravalent Ir salts. From the measurements, the assignment of spin ½ to the 73-keV level was confirmed, and the ratio of the magnetic moment of this level to the magnetic moment of the ground level was found to be 3.0 ± 0.1. The small value obtained for the magnetic moment of the first excited state can be explained by the core-excitation model of de Shalit. The results yielded a value of $\delta^2 = 0.37 \pm 0.06$ for the E2/M1 mixing ratio of the 73-keV transition. The absolute values of the internal magnetic fields acting on the Ir nuclei in iron and in the RIr_2 compounds were deduced. The dependence of these fields on the rare-earth element was found to follow approximately the predictions of the Kasuya–Yosida theory on conduction-electron polarization, though an exact fit between this theory and experiment was not obtained. The electric field gradients acting on the Ir nuclei in the hexagonal Os metal lattice, in some Ir salts, and in the various RIr_2 compounds were deduced. Isomer-shift measurements indicate that the sign of $\Delta\langle r^2\rangle$, the difference in the mean-square charge radii between the first excited state and ground state of ^{193}Ir, is positive. (auth)

1349 STRUCTURAL STUDIES OF SOME TELLURIUM COMPOUNDS USING THE MOESSBAUER EFFECT IN ^{125}Te AND ^{129}I NUCLEI. Pasternak, M.; Bukshpan, S. (Soreq Research Center, Yavne, Israel). Phys. Rev., 163: 297-303 (Nov. 10, 1967).

Structural information on tellurium compounds was obtained from Mössbauer-effect data measured with ^{129}Te sources. The compounds studied were tellurium metal, TeO_2, and $Te(NO_3)_4$. To check the reliability of the information obtained, experiments were also carried out using ^{125}Te absorbers. It was found that for the tellurium compounds, but not for tellurium metal, the ratio of the quadrupole coupling of the ^{129}Te sources to that of the ^{125}Te absorbers was constant, despite the differences in the ligands and structural properties of these compounds as revealed by differences in their isomer shifts and asymmetry parameters. It is concluded that the structure of TeO_2 (orthorhombic phase) resembles that of SeO_2, namely, a chain structure with three coordinated oxygens and an O–Te–O angle of 90°. From the significant magnitude of the asymmetry parameter, it is concluded that one of the Te–O bonds is longer than the other two. An appreciable anisotropy of the recoilless fraction was found in the case of TeO_2 and Te metal, confirming their chain character. For $Te(NO_3)_4$, the structure was found to be a tri- or tetrapyramid with the Te atom at the apex, equal Te–NO_3 bond distances, and a NO_3–Te–NO_3 angle close to 90°. The quadrupole moment of the ^{125}Te first excited state was calculated and found to be −0.19 ± 0.02 b. The energy-level positions in the ^{129}I quadrupole-split spectrum were calculated for intervals of 0.1 in η up to $\eta = 1$. It is shown that from the greater sensitivity of some transitions to the value of η, it is possible to get quite accurate values of η. (auth)

1350 RANGE–ENERGY RELATION AND ENERGY LOSS OF FISSION FRAGMENTS IN SOLIDS. Kahn, S.; Forgue, V. (Aerojet-General Nucleonics, San Ramon, Calif.). Phys. Rev., 163: 290-6(Nov. 10, 1967).

The energies of fission fragments transmitted through Al, Ni, Ag, Au, and U–Pd have been measured with surface-barrier detectors. The results, converted to the Lindhard–Scharff–Schiott (LSS) dimensionless parameters kρ (range) and ε (energy), were found to fit the empirical equation $k\rho = 1.158\epsilon^{\frac{1}{2}}[1 - \exp(0.0987\epsilon)] + 0.01939\epsilon$ in the region $12 \leq \epsilon \leq 348$. These results are 10 to 20% lower than those predicted by the LSS theory. A description is given of the effect of relatively simple modifications to this theory, and suggestions are presented for a more rigorous theoretical approach. (auth)

1351 INTERNAL MAGNETIC FIELDS AT Pt NUCLEI IN Pt–Fe ALLOYS. Buyrn, A.; Grodzins, L.; Blum, N. A.; Wulff, J. (Massachusetts Inst. of Tech., Cambridge). Contract AT(30-1)-2098. Phys. Rev., 163: 286-90(Nov. 10, 1967). (MIT-2098-333).

The Mössbauer effect of the 99-keV, $\frac{3}{2}^-$-to-$\frac{1}{2}^-$ transition in ^{195}Pt has been measured, using a single-line source of ^{195}Au in Cu and ferromagnetic Fe–Pt alloy absorbers. The internal field at the Pt nucleus, H_{int} (Pt), in the alloy absorbers was determined and found to be nearly constant, about 1.26×10^6 Oe, over a range of composition from 3 to 30 at. % Pt. H_{int} (Pt) for an $Fe_{0.50}Pt_{0.50}$ alloy absorber and for a source (^{195}Au → ^{195}Pt in Fe) are smaller, H_{int} (Pt) ≃ 1.0×10^6 and 0.85×10^6 Oe, respectively. The g factor of the state is found to be −0.40 ± 0.10 nm. (auth)

1352 QUANTUM-MECHANICAL MODEL OF MOESSBAUER LINE NARROWING. Harris, Samuel M. (Purdue Univ., Lafayette, Ind.). Contract AT(11-1)-1420. Phys. Rev., 163: 280-5(Nov. 10, 1967). (COO–1420-131).

A model for Mössbauer radiation is developed which includes both radiation and lattice-relaxation processes. The model describes an initially excited nucleus in an excited lattice. Both radiation and relaxation phenomena are treated in lowest order, so that a quantum-mechanical solution is possible. It is found that under certain conditions, Mössbauer lines result which are narrower than the natural line, although line broadening is the more usual effect of lattice relaxation. The maximum narrowing in this approximation never exceeds 36% of the natural width. (auth)

1353 OVERLAP CONTRIBUTION TO THE ISOMER SHIFT OF IRON COMPOUNDS. Simanek, E.; Sroubek, Z. (Univ. of California, Los Angeles). Phys. Rev., 163: 275-9(Nov. 10, 1967).

The electron density Ψ^2 (0) at the iron nucleus in oxides is calculated as a function of the Fe–O distance, by taking into account the overlap of the inner shells of iron with the oxygen 2p wave functions. The calculation shows the importance of the intershell terms, which effectively reduce the overlap-induced electron density. By comparing these results with the high-pressure isomer-shift measurements of divalent iron in CoO, the relative change of the ^{57}Fe nuclear radius is found to be less than -4.0×10^{-4}. The overlap effect provides an important amplification mechanism for the contribution of 4s bonding to Ψ^2 (0). On the basis of this mechanism, large increases in Ψ^2 (0) observed on going from Fe^{2+} to Fe^{3+} salts can be explained by a reasonable increase in the amount of 4s bonding. (auth)

1354 EFFECTIVE MAGNETIC FIELDS ON ^{150}Sm IN FERROMAGNETIC LATTICES. Murnick, D. E. (Massachusetts Inst. of Tech., Cambridge); Grodzins, L.; Bronson, J. D.; Herskind, B.; Borchers, R. R. Contract AT(11-1)-Gen-7. Phys. Rev., 163: 254-60(Nov. 10, 1967). (COO–7-0418).

The ion-implanation perturbed-angular-correlation technique has been used to determine the hyperfine magnetic fields on samarium-150 nuclei in ferromagnetic iron, cobalt, nickel, and gadolinium lattices. Assuming the published value of 1400 kG for the field on samarium in iron, it follows that the hyperfine fields on samarium in cobalt and nickel, at 300°K, are 1119 ± 64 and 352 ± 13 kG, respectively; and in gadolinium at 110°K, −295 ± 30 kG. The hyperfine fields in iron, cobalt, and nickel are proportional to the atomic moments of the respective hosts. The major contribution to the field on samarium in gadolinium can be accounted for by polarized conduction-electron exchange. The gyromagnetic ratio for the 334-keV 2^+ level in ^{150}Sm is determined to be 0.47 ± 0.06. (auth)

1355 FANO FACTOR IN GERMANIUM AT 77°K. Bilger, Hans R. (Argonne National Lab., Ill.). Phys. Rev., 163: 238-53(Nov. 10, 1967).

The Fano factor in germanium at liquid-nitrogen temperature has been found to be F = 0.129 ± 0.003 using γ rays at energies from 0.122 to 4.8 MeV. F appears to be independent of the primary energy in the investigated energy range. Care has been exercised to eliminate the influence of ballistic deficit, recombination, and trapping in planar lithium-drifted structures as well as noise, drift, and pile-up in the apparatus. Measurements with crystals having volumes from 0.8 to 13 cm gave consistent results. The line shift and the linewidth dependence was up to and into electric field strengths where saturation of electron and hole velocities occurs. (auth)

1356 NUCLEAR MAGNETIC RESONANCE AND RELAXATION OF ^{197}Au IN GOLD METAL AND ^{109}Ag IN GOLD–SILVER ALLOYS. Narath, Albert (Sandia Lab., Albuquerque, N. Mex.). Phys. Rev., 163: 232-7(Nov. 10, 1967).

The nuclear magnetic resonance (NMR) of ^{197}Au has been observed for the first time. Transient NMR experiments on metallic gold in the temperature range 1-4°K, and in external magnetic fields near 57 kOe, gave a frequency-to-field ratio $\nu^{(197)}/H$ = 0.074119(4)kHz/Oe, a spin-echo phase-memory time $T_2 \approx 2$ msec, and spin-lattice relaxation times T_1 which are inversely proportional to the absolute temperature T with $T_1T = 4.6 \pm 0.4$ sec °K. Comparison of the experimental $\nu^{(197)}/H$ ratio with recent atomic-

beam resonance measurements of $\mu^{(197)}$ leads to a Knight shift in gold metal K = +(1.64 ± 0.02)%. Results of related measurements on ^{109}Ag in Ag_xAu_{1-x} alloys are also reported [x = 0.75 : K = (+0.507 ± 0.005)%, T_1T = 10.0 ± 0.5 sec °K; x = 0.50 : K = +(0.454 ± 0.010)%, T_1T = 13.6 ± 0.8 sec °K; x = 0.25 : K = +(0.416 ± 0.010)%, T_1T = 15.2 ± 1.0 sec °K; x = 0.05: K = +(0.392 ± 0.010)%, T_1T = 17 ± 1 sec °K]. Magnetic-field measurements in these experiments were based on a silver-metal reference for which a direct comparison of the 4°K ^{109}Ag NMR frequency with the room-temperature frequency of ^{2}H in heavy water yielded $\nu^{(109)}/H = 0.199133(4)$kHz/Oe. The measured Knight shifts and spin-lattice relaxation rates are used to estimate the exchange enhancements of the respective static conduction-electron spin susceptibilities, as well as the ratios of the average contact hyperfine fields in the metals to those in the corresponding free atoms. (auth)

1357 DYNAMIC PROTON POLARIZATION IN NEODYMIUM-DOPED YTTRIUM ETHYL SULFATE. Wollan, David S.; Stapleton, H. J. (Univ. of Illinois, Urbana). Phys. Rev., 163: 207-12(Nov. 10, 1967).

The dynamic proton polarization attainable by the solid effect was in single crystals of neodymium-doped yttrium ethyl sulfate at 9.5 and 69.5 GHz at liquid-helium temperatures. All measurements were made using naturally abundant neodymium isotopes. At 9.5 GHz the forbidden satellite transitions were unresolved from the allowed ESR line and the highest observed proton polarization (1%) was obtained for a 1% Nd doping at 4.2°K. Lower concentrations and lower temperatures both produced smaller proton polarizations. At 69.5 GHz and 16.2 kOe, the satellites were well resolved but the maximum observed proton polarization was only 21.5% at 2.1°K, whereas the theoretical maximum under these conditions is 66%. The polarizations achieved at 69.5 GHz and 4.2°K were severely limited by insufficient microwave power. The results at 2.1°K and 695 GHz are examined in terms of theories applicable under various conditions, and no explanation of the low polarizations is found. (auth)

1358 MOESSBAUER-EFFECT STUDY OF THE MAGNETIC STRUCTURE OF SINGLE-CRYSTAL ERBIUM. Reese, R. A.; Barnes, R. G. (Iowa State Univ., Ames). Contract W-7405-eng-82. Phys. Rev., 163: 465-71(Nov. 10, 1967). (IS-1518).

The magnetic structures of erbium metal have been investigated using the Mössbauer effect with single-crystal absorbers and a paramagnetic $HoAl_2$ source. Measurements were performed between 4.2 and 80°K on two single crystals, one with the c axis parallel and the other perpendicular to the γ-ray beam. At 4.2°K an analysis of the relative areas of the five resonance lines yields a value of (26 ± 3)° for the semiapex angle of the ferromagnetic cone. No analysis was made on data from the intermediate-temperature region, because of the small effect. In the high-temperature region, a two-line spectrum was obtained at 55°K with the c axis parallel to the beam. The data are best fitted by two Lorentzian lines, but an approximate fit can be achieved with a distribution of Lorentzian lines appropriate to a continuous sinusoidal distribution of hyperfine field values. At the Néel temperature of 80°K, a single-line spectrum was found with a full width at half-maximum of 0.34 cm/sec. (auth)

1359 EFFECT OF ANNEALING ON THE LATTICE PARAMETER OF NEUTRON-IRRADIATED COPPER. Himmler, U. (Technische Hochschule, Darmstadt, Ger.); Peisl, H.; Sepp, A.; Waidelich, W.; Wenzl, H. Phys. Rev. Lett., 19: 956-7(Oct. 23, 1967).

Pure Cu single crystals were irradiated in the low-temperature facility of the Munich Research Reactor and transferred without raising the temperature to a special He cryostat for measurement of the lattice parameter by x-ray scattering. The crystals were then warmed in steps to successively higher temperatures with an isochronal holding time of 10 min, and relative lattice parameter changes were measured as a function of annealing temperature. Results were compared with annealing of electric resistivity change after neutron irradiation at the same position in the reactor. The thermal annealing of lattice parameter and resistivity change proceeds in annealing stages lying in the same temperature regions, but the relative height of the stages is different for the two properties. (A.G.W.)

1360 DEUTERON MAGNETIC RESONANCE IN SOLID AND LIQUID SiD_4 ABOVE 36°K. Lahteenmaki, U.; Niemela, L.; Pyykko, P. (Univ. of Turku, Finland). Phys. Lett., 25A: 460-1 (Sept. 25, 1967).

Deuteron magnetic resonance in SiD_4 has been studied by the absorption and pulse methods between 36 and 156°K. The solid state phase transition temperature is measured as 67 ± 1°K. For the deuteron quadrupole coupling constant the value 95 kHz is obtained. Rotational potential barriers are discussed. (auth)

1361 RELAXATION AND EXCHANGE INDUCED QUADRUPOLE EFFECTS IN $KFeF_3$. Fatehally, R.; Shenoy, G. K.; Sastry, N. P.; Nagarajan, R. (Tata Inst. of Fundamental Research, Bombay). Phys. Lett., 25A: 453-5(Sept. 25, 1967).

The Moessbauer spectra of $KFeF_3$ below T_N(= 115°K) give H_{eff} and induced EFG's. Above 95°K, relaxation effects appear. Computed values using a Hamiltonian $\lambda L \cdot S - hS_z$ agree with the experiment. The self-consistent calculation yields an exchange integral 5.38°K. (auth)

1362 ANOMALOUS TEMPERATURE DEPENDENCE OF THE HYPERFINE FIELDS AT Sn IN COBALT. Jain, A. P.; Cranshaw, T. E. (United Kingdom Atomic Energy Research Establishment, Harwell, Eng.). Phys. Lett., 25A: 421-2 (Sept. 25, 1967).

The hyperfine field at ^{119}Sn in Fe, fcc Co, hexagonal Co, and Ni was investigated as a function of temperature between 4.2 and 883°K. An anomalously large decrease in the field is observed in fcc and hexagonal cobalt alloys. (auth)

1363 CHARACTERISTIC EXTREME uv EMISSION FROM CHANNELED POSITIVE IONS. Khan, J. M. (Univ. of California, Livermore); Potter, D. L.; Worley, R. D.; Salem, S. I.; Smith, Harold P. Jr. Contract W-7405-eng-48. Phys. Rev. Lett., 19: 950-2(Oct. 23, 1967). (UCRL-70598).

Experiments were conducted to measure the photon yield resulting from neutralization of charged particles incident on crystals. A single crystal of Cu was exposed to a monoenergetic proton beam. The intensity of the Cu L radiation and that of the hydrogen 1216 Å line were measured as a function of the angle of incidence for 70-keV protons. The data indicate that the widths of the yield profile observed under the same energy conditions by the two different methods are the same, and, within experimental error, have the same dependence on energy of the incident particle. The channeling of He^+ particles in a Cu single crystal was also observed. The channeling of He^+ particles was clearly observable but less pronounced with the He 584 Å line than with the Cu L radiation. (A.G.W.)

1364 THERMAL EXPANSION AT LOW TEMPERATURES OF ANISOTROPIC METALS: INDIUM. Collins, J. G.; Cowan, J. A.; White, G. K. (CSIRO., Sydney). Cryogenics, 7: 219-24(Aug. 1967).

Measurements of the linear thermal expansion of single crystals of indium at temperatures down to 2°K show the following features: (1) Normal to tetrad axis, the expansion coefficient $\alpha_\perp$ is positive at all temperatures but has a small maximum at 7°K and minimum at 13°K. (2) Parallel to the tetrad axis, $\alpha_{||}$ is negative below 7°K, has a maximum positive value of approximately 24×10^{-6}/deg K at 30°K and becomes negative again at room temperature. (3) The volume coefficient $\beta = 2\alpha_\perp + \alpha_{||}$ increases with T in similar fashion to the heat capacity so that the Gruneisen parameter remains between 2.2 and 2.4 from 2 to 300°K. (4) Below T_c, length differences between the superconducting (s) and normal (n) states $l_s - l_n$, are positive for the parallel orientation and negative for the perpendicular. From these differences it is found $(dH_c/dp)_{T=0} = -3.9 \times 10^{-3}$ and $(dH_c/dp)_{T=Tc} = -6.6 \times 10^{-3}$ Oe/kbar. Also $d\ln H_0/d\ln V = 6.4$ and $d\ln T_c/d\ln V = 5.7$. (auth)

1365 ELEMENTARY THEORY OF METALS. The International Encyclopedia of Physical Chemistry and Chemical Physics. Topic 11. The Ideal Crystalline State. Volume 2. Donovan, B. New York, Pergamon Press, 1967. 270p. $13.50.

Topics covered are: basic quantum mechanical principles, approximation methods, the energy of many-electron systems, the free electron approximation, the motion of electrons in a periodic lattice, the electronic structure of metals, the mechanism of conductivity, the formal theory of transport phenomena, and high frequency properties of metals. (M.H.R.)

1366 DYNAMICAL PROCESSES IN SOLID STATE OPTICS. 1966 Tokyo Summer Lectures in Theoretical Physics. Part I. Kubo, Ryogo; Kamimura, Hiroshi (eds.). Tokyo, Syokabo Publishing Co., and New York, W. A. Benjamin, Inc., 1967. 252p.

Texts of ten principal lectures on dynamic processes in solid-state optics are presented. Three main topics are covered: the physics underlying the macroscopic optical properties of a dielectric medium; origins of various structures appearing in spectra of solids; and fundamental problems in lasers and masers. (M.H.R.)

Theoretical Physics

Refer also to abstracts 841, 996, 1003, 1004, and 1069.

1367 (NYO-3699-16) COHERENT STATE AND ITS APPLICATION TO QUANTUM STATISTICAL MECHANICS. Dy, Kian Seng (Cornell Univ., Ithaca, N. Y.). June 1967. Contract AT(30-1)-3699. 63p. Dep. CFSTI.

Thesis.

The purpose of the present work is to exhibit the utility of coherent states basis in quantum statistical mechanics. The mathematical techniques which make the application of the coherent states possible are developed. The connection between the coherent states representation and classical mechanics is established. Applications are extended to nonequilibrium statistical mechanics. Specifically, the system of phonon excitations in an anharmonic solid is considered. Transport theory in the coherent states representation is considered. The problem of phonon scattering by impurities is considered in an appendix. (W.D.M.)

1368 (SC-T-67-0952) TWO-CENTER PROBLEM OF QUANTUM MECHANICS. PART I. Ponomarev, L. I.; Puzynina, T. P. (Joint Inst. for Nuclear Research, Dubna (USSR)). Translated by Marcel I. Weinreich (Sandia Corp., Albuquerque, N. Mex.), from report JINR-P2-3009. 28p. Dep. CFSTI. JCL $2.60 fs, $0.80 mf.

The results of numerical calculations of the two-center problem of quantum mechanics are given. Some interesting properties of the systems Z_1eZ_2 are observed for the $Z_1 = 1$ and $Z_2 = 3, \ldots, 8$ values. In particular the existence of the σ-term intersections in such a system, which were previously predicted by theory, is proved. The existence of stable states of molecular ions for large distances between the nuclei Z_1 and Z_2 is proved. Such a peculiar phenomenon, pseudointersections of terms, having no dynamical nature is found out. Possible applications of the results obtained are discussed. (auth)

1369 (SC-T-67-0953) TWO-CENTER PROBLEM OF QUANTUM MECHANICS. III. TERM TABLES. Ponomarev, L. I.; Puzynina, T. P. (Joint Inst. for Nuclear Research, Dubna (USSR)). Translated by Marcel I. Weinreich (Sandia Corp., Albuquerque, N. Mex.), from report JINR-P4-3175. 65p. Dep. CFSTI. JCL $6.60 fs, $2.18 mf.

The tables are listed which present the results of calculations for some terms of the two-center problem of quantum mechanics which were obtained by the method suggested in the previous papers. (auth)

1370 PARAXIAL CHARGED-PARTICLE MOTION IN ARBITRARILY VARYING, AZIMUTHALLY SYMMETRIC ELECTRIC AND MAGNETIC FIELDS. Gordon, E. I.; Miller, R. C. (Bell Telephone Labs., Inc., Murray Hill, N. J.). J. Appl. Phys., 38: 4911-15(Nov. 1967).

The paraxial motion, described in terms of the guiding center and gyroradius of noninteracting charged particles in arbitrarily varying, azimuthally symmetric electric and magnetic fields, is considered. In particular, the case where the magnetic field passes through zero is treated exactly. It is shown that a complete interchange of the guiding center and radius vector coordinates can be obtained for a nonimpulsive field reversal. The formalism has use in electron optics as well as transverse wave-beam interactions. (auth)

1371 INTEGRAL FORMULA FOR TWO-DIMENSIONAL FIELDS. Beth, Richard A. (Brookhaven National Lab., Upton, N. Y.). J. Appl. Phys., 38: 4689-92(Nov. 1967). (BNL-11557).

The complex analytic function treatment previously given [J. Appl. Phys., 37: 2568(1966)] for two-dimensional magnetic fields outside conductors is extended to regions of constant current density, σ, inside conductors. Separate analytic functions for field points $Z = X + iY$ inside and outside such conductors are given by the integral formula $F(Z) = i\sigma\oint z^*dz/(z - Z)$, where z^* is the complex conjugate of $z = x + iy$ on the conductor circumference. The complex field $H = H_Y + iH_X$ is then $F(Z) + 2\pi\sigma Z^*$ for points Z inside the conductor and $F(Z)$ for Z outside. If σ is replaced by $-i\rho$ the field $E = E_Y + iE_X$ is obtained in the analogous electrostatic case with constant charge density ρ, e.g., for a uniform beam of charged particles. The results are illustrated by evaluating the integral for an elliptical contour. (auth)

1372 TEMPERATURE DEPENDENCE NEAR PHASE TRANSITIONS IN CLASSICAL AND QUANTUM MECHANICS CANONICAL STATISTICS. Grossmann, S.; Rosenhauer, W. (Univ., Marburg, Ger.). Z. Phys., 207: 138-52(1967).

The free energy of a many-body system, classical as well as quantum mechanical, is represented by a finite Laplace transform of the interaction phase volume for stable potentials for which the thermodynamic limit exists. Possible singular and regular phase transitions are discussed with respect to the temperature dependence and are classified by the behavior of a limiting density of complex temperature zeros. The phenomenologically known types are reproduced. (auth)

1373 ON THE PHYSICAL MEANING OF THE FREUNDLICH-FORBES EMPIRICAL CONSTANT. Gasanalizade, A. G. (Pulkovo Astronomical Observatory, Baku. Shemakha Astrophysical Observatory, Baku). Solar Phys., 1: 481-3(June 1967).

It is shown that the so-called "interaction displacement" (constant Y) coincides with very high accuracy with the theoretical constant $\lambda_{L\odot}$. The latter is the value of the Einstein gravitational red shift of the Lyman series limit of hydrogen in the solar spectrum. (W.D.M.)

1374 PHYSICS POCKET BOOK. Ebert, H. (ed.). London, Oliver and Boyd, 1967. 575p. 63s.

Translation from German text Physikalisches Taschenbuch.

This book comprises a collection of theoretical derivations, formulae, and important data over a wide range of physics and applied mathematics. Sections are included on theory of relativity, quantum theory, magnetism and electromagnetism, atomic and nuclear physics, and strength of materials. (UK)

PHYSICS (HIGH ENERGY)

Particle Interactions and Properties (Experimental)

1375 (BMwF-FBK-67-55) JAHRESBERICHT, 1965. (Annual Report, 1965). (Physikalisches Staatsinstitut (II), Hamburg (West Germany)). June 1967. 44p. (In German). Dep.

Investigations at the II. Physikalisches Staatsinstitut der Universität Hamburg include experimental and theoretical studies in the field of high energy physics as well as in the nuclear sector. High energy physics is investigated especially by evaluation of bubble chamber pictures and by studies of production processes of elementary particles. Concerning nuclear physics investigations stress is laid on the spectroscopy of nuclei and the study of reaction mechanisms. These experiments are carried out with a 3-MeV van de Graaff generator and by means of radioactive preparations. (auth)

1376 (NYO-2171-233) THEORETICAL AND EXPERIMENTAL RESEARCH ACTIVITIES IN HIGH-ENERGY PHYSICS. Progress Report, September 1966–September 1967. (Pennsylvania Univ., Philadelphia. Dept. of Physics). Sept. 28, 1967. Contract AT(30-1)-2171. 50p. Dep. CFSTI.

A summary of investigations in theoretical and experimental elementary particle physics and nuclear theory is given. This research includes methods in nuclear shell structure theory, nonleptonic hyperon decay studies, the K_{l3} form factors, high-energy scattering theory, the effect of pion exchange in nuclear weak interactions, and work on several model theories. (J.F.P.)

Electromagnetic

Refer also to abstract 367.

1377 PHOTOPRODUCTION OF π^+ AT 0° AND FORWARD ANGLES BETWEEN E_γ = 300 AND E_γ = 600 MeV. Bizot, J. C.; Perez-y-Jorba, J. P.; Treille, D. (Ecole Normale Superieure, Orsay, France). Phys. Lett., 25B: 489-92(Oct. 16, 1967).

A measurement of π^+ photoproduction at zero degree and small angles in the unknown region between the highest measurement of Knapp et al. (E_γ = 290 MeV) and the lowest measurement of Beneventano et al. (E_γ = 550 MeV) was made. (auth)

1378 PHOTOPRODUCTION OF NEUTRAL PIONS ON PROTONS IN THE NEARTHRESHOLD ENERGY REGION. Govorkov, B. B.; Denisov, S. P.; Minarik, E. V. (Lebedev Inst. of Physics, Moscow). Yadern. Fiz., 6: 507-14(Sept. 1967). (In Russian).

Results on the angular distributions of π^0-mesons produced in the process $\gamma + p \rightarrow p + \pi^0$ at the energies of 163 and 234 MeV are given as well as the results of repeated measurements of angular distribution at the energy 212 MeV. For completeness, the results at 181 MeV are reproduced. It has been established that the angular distributions in c.m. system are best approximated by the expression of the type $d\sigma/d\Omega = A + B \cos\theta + C \cos^2\theta$. (auth)

Weak

Refer to abstract 1389.

Strong (Baryon-Induced)

1379 (JINR-P2-3508) MNOGOCHASTICHNYE VZAIMODEISTVIYA V OBLASTI VYSOKIKH I SVERKHVYSOKIKH ENERGII. (Many-Particle Interactions at High and Superhigh Energies). Artykov, I. Z.; Barashenkov, V. S.; Eliseev, S. M. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1967. 7p. (In Russian). Dep.

Using the Monte-Carlo method the nucleon-nucleus interactions are analyzed at energies higher than 100 GeV. The characteristics of many-particle interactions are determined. (auth)

1380 THE REAL PART OF THE AMPLITUDE OF PROTON–PROTON SCATTERING AT AN ENERGY OF 3 GeV. Grossmann, P.; Korbel, Z.; Rob, L. (Czech Technical Univ., Prague). Czech. J. Phys., 17: 830-2(1967).

Measurement of the differential cross sections of proton-proton scattering at an energy of 3 GeV is described. The measurement was performed in the region of angles from 2.4 to 16.2°. Analysis of the experimental data shows that besides the imaginary scattering amplitude a real part is also necessary in order to describe elastic scattering at an energy of 3 GeV; the magnitude of the real part is 24% of the magnitude of the imaginary part. (auth)

1381 DETERMINATION OF THE REAL PART OF ELASTIC PROTON–NEUTRON SCATTERING AT AN ENERGY OF 8 GeV. Korbel, Z.; Rob, L. (Czech Technical Univ., Prague). Czech. J. Phys., 17: 833-8(1967).

Elastic pd scattering at an energy of 8 GeV was studied by means of the improved method of the multiple passage of protons through a target 0.6 μm thick, made of $(CD_2)_n$. It was determined from an analysis of the differential cross section that the magnitude of the real part of the amplitude is 26% of the magnitude of the imaginary part. The real part of the elastic pn scattering amplitude was calculated using the results of the study of the elastic pp scattering at an energy of 8 GeV; its magnitude is 30% of the magnitude of the imaginary part. (auth)

1382 TWO MESON FINAL STATES IN INTERACTIONS OF 2.7 GeV/c $\bar{p}p$. Domingo, V.; Fisher, G. P.; Libby, L. Marshall; Sears, R. (Univ. of Colorado, Boulder). Contract AT(11-1)-1537. Phys. Lett., 25B: 486-8(Oct. 16, 1967).

The cross sections for $\pi^+\pi^-$, K^+K^-, and $\bar{K}^0K^0$ final states from 2.7-GeV/c $\bar{p}p$ interactions are 28 ± 9 μb, 3^{+4}_{-3} μb, and <10 μb respectively. Angular distributions are presented and discussed. (auth)

1383 INVESTIGATION OF MULTIPLE MESON PRODUCTION IN PROTON–PROTON COLLISIONS AT 20 GeV. Boos, E. G.; Pavlova, N. P.; Pervushina, V. L.; Rus'kina, G. Ya.; Takibaev, Zh. S. (Inst. of Nuclear Physics, Alma-Ata, USSR). Yadern. Fiz., 6: 534-40(Sept. 1967). (In Russian).

Inelastic pp interactions at E = 20 GeV are investigated with the thick nuclear emulsion. The results are compared with the data obtained on the hydrogen bubble chambers. The angular and the momentum distributions of the secondary charged particles are analyzed. It is shown that the proton angular distribution is sharply anisotropic and symmetric and does not vary with the multiplicity. Number of protons per interaction is found to be 0.80 ± 0.05. The momentum spectrum of the secondary protons does not agree with the predictions of the statistical or peripheral models. The best fit may be obtained if the two mechanisms contribute 60% and 40% respectively. The inelasticity coefficient is determined (K_{pp} = 0.68 ± 0.02), the energy carried away by the charged mesons being equal to the energy of the neutral component. (auth)

1384 PRODUCTION OF THE UNDERBARRIER π MESONS IN THE INTERACTION OF PROTONS WITH ENERGY 9 GeV WITH HEAVY NUCLEI OF THE EMULSION. Kostanashvili, N. I.; Lebedevich, G. I.; Nabichvrishvili, D. S. (Tbilisi State Univ., USSR). Yadern. Fiz., 6: 528-33(Sept. 1967). (In Russian).

Production of the $\pi^\pm$-mesons with energies ≤ 11 MeV on heavy nuclei of the emulsion is studied experimentally. The observed fractional yields of the π^-- and π^+-mesons are compared with the calculated values obtained with the interaction between the producted π-mesons and the final nucleus taken into account in framework of the optical model. (auth)

Strong (Meson-Induced)

1385 (SLAC-PUB-347) EVIDENCE FOR A T = 0 THREE PION RESONANCE AT M ~ 990 MeV. Chadwick, G. B.; Guiragossian, Z. G. T.; Pickup, E. (Stanford Linear Accelerator Center, Calif.); Barbaro-Galtieri, A.; Matison, M. J.; Rittenberg, A. (California Univ., Berkeley. Lawrence Radiation Lab.). Sept. 1967. 13p. (CONF-670934-6). Dep. CFSTI.

From International Conference on Elementary Particles, Heidelberg, Germany.

In a study of the interaction $K^- + n \rightarrow \Sigma^- + \pi^+ + \pi^- + \pi^0$ from an exposure of a 2.1- and 2.65-GeV/c K^- beam in the deuterium bubble chamber, evidence for a resonance in the neutral 3π system at 990 MeV is found. An upper limit on the true width of this state is 55 MeV. This state is tentatively identified as having the same properties as the meson (H). (J.F.P.)

1386 (SLAC-PUB-348) Y^* PRODUCTION IN 2.1 AND 2.65 GeV/c K^-n INTERACTIONS. Chadwick, G. B.; Guiragossian, Z. G. T.; Pickup, E. (Stanford Linear Accelerator Center, Calif.); Barbaro-Galtieri, A.; Matison, M. J.; Rittenberg, A. (California Univ., Berkeley. Lawrence Radiation Lab.). Sept. 1967. 14p. (CONF-670934-7). Dep. CFSTI.

From International Conference on Elementary Particles, Heidelberg, Germany.

The Σ^- and Λ^0 producing channels of K^-–deuteron interactions

at 2.1 and 2.65 GeV/c incident momenta in a deuterium bubble chamber were studied. Among the 3- and 4-prong topologies containing a negatively charged decay, a total of 5822 events for the interactions $K^- + d \rightarrow \Sigma^- + \pi^+ + \pi^-$ and $K^- + d \rightarrow \Sigma^- + \pi^+ + \pi^0 + \pi^-$ were found. Also the 1- and 2-prong with V_0 topologies gave a total of 12,623 successfully processed events. The reactions of interest are $K^- + d \rightarrow \Lambda^0 + \pi^-$ + missing mass and $K^- + d \rightarrow \Lambda^0 + \pi^- + \pi^0$. The various channel cross sections, masses, experimental widths, and amount of resonant states at both energies are listed. (J.F.P.)

1387 (UCRL-17833) CONFIRMATION OF THE L-MESON BY USE OF A HYDROGEN BUBBLE CHAMBER AS A MISSING MASS SPECTROMETER. Firestone, Alexander; Goldhaber, Gerson; Shen, Benjamin C. (California Univ., Berkeley. Lawrence Radiation Lab.). Sept. 14, 1967. Contract W-7405-eng-48. 12p. (CONF-670934-5). Dep. CFSTI.

From International Conference on Elementary Particles, Heidelberg, Germany.

The 80-inch BNL liquid hydrogen bubble chamber was used as a missing mass spectrometer in K^+p interactions at 9 BeV/c, and for those events with stopping-protons, the existence of the L-meson with observed mass M = 1740 MeV and full width at half maximum Γ = 120 MeV is confirmed. (auth)

1388 THE STUDY OF π^+ MESON-PROTON INTERACTION AT 2.34 GeV/c. Zlateva, A. I.; Kerachev, P. P.; Penev, V. N.; Semerdzhiev, Kh. I.; Khristov, M. I.; Shklovskaya, A. I. (Inst. of Physics, Sofia). Compt. Rend. Acad. Bulg. Sci., 20: 413-16(1967). (In Russian).

Preliminary results gathered during the study of π^+-p interaction at 2.34 GeV/c are reported. Bubble chamber photographs were obtained at the 40-cm machine exposed to π^+ mesons from the synchrocyclotron. The results extracted from 20,000 scanned photographs cover differential cross sections, relative interaction cross sections of various interaction channels, spectra of effective masses, and Treiman-Yang angular distribution. The interference of π-mesons and N^{*++} isobars seems not to exceed 20%; the one-pion exchange mechanism cannot justify all the observed results. (JPRS)

1389 OBSERVATION OF THE e^+e^- DECAYS OF NEUTRAL VECTOR MESONS. Azimov, M. A.; Baldin, A. M.; Belousov, A. S.; (and others) (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz., 6: 515-27(Sept. 1967). (In Russian).

Cross sections of the e^+e^--pair production in the reaction $\pi^- + p \rightarrow \nu^0 + n$, $\nu^0 \rightarrow e^+e^-$ are measured at the incident pion momentum p = 4.0 GeV/c by means of the spark chambers and the Cherenkov gamma spectrometers operating jointly. 13 events were detected and identified as the $\rho \rightarrow e^+e^-$- and $\omega \rightarrow e^+e^-$-decays, and also one event identified as the $\varphi \rightarrow e^+e^-$-decay. Two independent determinations of the e^+e^--decay widths of the vector meson octet are fulfilled and the branching ratios are calculated from the obtained cross sections using the data on the vector meson production cross sections available in the literature, as well as with the value of $\theta_i = 38°$ for the $\omega - \varphi$-mixing. The results are $\Gamma(\rho \rightarrow e^+e^-)/\Gamma(\rho) = (0.39 \pm 0.12) \cdot 10^{-4}$, $\Gamma(\omega \rightarrow e^+e^-)/\Gamma(\omega) = (0.48 \pm 0.15) \cdot 10^{-4}$, $\Gamma(\varphi \rightarrow e^+e^-)/\Gamma(\varphi) < 2 \cdot 10^{-3}$. (auth)

1390 POLARIZATION OF THE Σ^+ HYPERONS PRODUCED ON THE COMPLEX TARGET. Kolganova, E. D.; Minervina, Z. V.; Pozharova, E. A.; Smirnitskii, V. A. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz., 6: 505-6(Sept. 1967). (In Russian).

Polarization of the Σ^+ hyperons produced on the polyethylene target (CH_2) in the reactions $\pi^+ + p \rightarrow \Sigma^+ + K^+$ and $\pi^+ + n \rightarrow \Sigma^+ + K^0$ at the π^+ momentum 1.1 GeV/c was measured by means of the nuclear emulsion method. The polarization was determined from the asymmetry of 194 decay events and is found to be $\alpha P = 0.63 \pm 0.24$. (auth)

1391 f^* PRODUCTION IN K^-p INTERACTIONS AT 5.5 GeV/c. Ammar, R. (Northwestern Univ., Evanston, Ill.); Davis, R. E. P.; Hwang, C.; Kropac, W.; Mott, J.; Werner, B.; Dagan, S.; Derrick, M.; Schweingruber, F.; Simpson, J. Phys. Rev. Lett., 19: 1071-4(Oct. 30, 1967).

The f^* meson was observed, with a partial cross section of 14 ± 4 μb, in the reaction $K^- + p \rightarrow \Lambda + f^*$, at 5.5 GeV/c. Its mass was measured as 1515 ± 7 MeV, with a width of 35 ± 25 MeV, considerably narrower than previously measured. The decay into $K\bar{K}$ was the dominant mode, with no significant evidence for decay into $\pi\pi\eta$, $\pi\pi$, $K^*\bar{K}$, or $\bar{K}^*K$. The production and decay angular distributions are presented and analyzed in terms of the spin-density matrix formalism. (auth)

Particle Interactions and Properties (Theoretical)

General

Refer also to abstracts 1376, 1487, and 1514.

1392 (ITF-67-11) ISSLEDOVANIE KINETICHESKOGO URAVNENIYA DLYA MODELI S VOZBUZHDENNYM UROVNEM. (Investigation of Kinetic Equations for Models with Excited States). Shelest, A. V. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1967. 10p. (In Russian). Dep.

The irreversible character of the kinetic equation is studied. The entropy is shown, in the general case, to grow with increasing time. A solution of the kinetic equation is obtained for the model of a fermion with an excited level. It is shown that in the asymptotic case ($t \rightarrow \infty$) the density matrix of the system tends to its equilibrium value. (auth)

1393 (JINR-E2-3470) ON WAVE FUNCTIONS OF UNSTABLE PARTICLE. Jersak, J. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1967. 11p. Dep.

It is shown that wave functions describing an unstable particle must obey a simple condition which leads to the relation between the number of these wave functions and decay laws of the particle. (auth)

1394 (JINR-E2-3509) ON THE UPPER LIMIT OF THE RADIUS OF ELEMENTARY PARTICLES. Nguyen Van Hieu (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1967. 8p. Dep.

Some upper bounds are obtained for the mean square radius of the elementary particles depending on the behavior of the modulus of the form factor on the cut. (auth)

1395 NEW APPROACH TO THE MANY-BOSON PROBLEM. Kanno, Shokichi (Osaka Univ.). Progr. Theor. Phys. (Kyoto), 38: 508-10(Aug. 1967).

A method of approach for the many-boson problem is introduced by using a nonlinear canonical transformation. Using this method the operators of the zero-momentum state of the single particle are considered as q-number quantities in contrast to the Bogoliubov theory. Unlike the conventional treatments of the many-body problem, the adiabatic approximation is dispensed with, and the energy eigenvalue always remains real. A system of interacting bosons is considered. (J.F.P.)

1396 COMPOSITENESS CONDITION FOR PARTICLES WITH IDENTICAL QUANTUM NUMBERS. Hirayama, Minoru (Kyoto Univ.). Progr. Theor. Phys. (Kyoto), 38: 476-90(Aug. 1967).

The second compositeness condition other than det Z = 0 is proposed as $8 \xrightarrow{\lim} \infty$ s det Z(s) = 0 for two particles with identical quantum numbers. It is shown that this condition takes the same form irrespective of the ambiguity in extracting the one-particle irreducible part from a full scattering amplitude with a composite particle in its channel. The detailed meaning of the above condition is investigated in a modified Srivastava model and it is shown that it corresponds to the vanishing of the Jouvet limit parameter, i.e., the complete vanishing of one of the two bare vertices. (auth)

1397 TO THE ANALYSIS OF THE SCHROEDINGER EQUATION FOR A SYSTEM OF n INTERACTING PARTICLES. Savchenko, O. Ya. Yadern. Fiz., 6: 645-8(Sept. 1967). (In Russian).

A lower and an upper limit on the eigennumbers of the Schroedinger equation are determined for a system of n interacting particles with equal masses. An analog of the Born formula is presented for the scattering of a particle on a system of bound particles as well as conditions under which one may neglect the fact that they are bound. (auth)

1398 CONNECTION OF HIGH-ENERGY PARAMETERS WITH THE LOW-ENERGY SCATTERING. Vail, A. N. (Inst. of Mathematics, Novosibirsk, USSR). Yadern. Fiz., 6: 635-7 (Sept. 1967). (In Russian).

Approximating the high-energy contribution into the low-energy scattering amplitude the connection of positions and widths of resonances with high-energy parameters is shown. (auth)

1399 CURRENT ALGEBRA AND VERTEX FUNCTIONS. Arnowitt, R.; Friedman, M. H.; Nath, P. (Northeastern Univ., Boston). Phys. Rev. Lett., 19: 1085-8(Oct. 30, 1967).

A method is given for calculating vertex functions involving three

currents obeying chiral SU(2) ⊗ SU(2) commutation relations, without using soft-pion approximations. The procedure assumes one-particle dominance of intermediate states. The Weinberg sum rule emerges as a consequence of the vanishing of q-number Schwinger terms. The charge radius of the pion is obtained and is in agreement with existing data. (auth)

1400 ALGEBRAIC THEORY OF PARTICLE PHYSICS. HADRON DYNAMICS IN TERMS OF UNITARY SPIN CURRENTS. Ne'eman, Yuval. Frontiers in Physics Series. New York, W. A. Benjamin, Inc., 1967. 347p.

The theory of elementary particles is presented in a comprehensive view based on the use of the components of unitary spin as the main dynamical objects. The abstract algebra of unitary spin, the role of algebras in quantum mechanics, compact and non-compact generators and groups, unitary symmetry, the physical algebra of unitary spin, and the application of SU(3) to hadron electromagnetic and weak interactions are covered. Also discussed are the algebra of scalar and pseudoscalar integrated groups, the U(12) TOA of space integrals of current components and its ASA subsets, algebra of factorized Regge residues, and the search for the hadron spectrum-generating algebra. (J.F.P.)

1401 WAVE MECHANICS. Flint, H. T. Science Paperback SP36. New York, Barnes and Noble, Ind., 1967. 158p. $2.35 paper; $4.50 cloth.

Attention is given to the work of DeBroglie and Schrödinger. This consists in the association of a wave-like character with what was hitherto regarded merely as corpuscles. The Dirac theory is also considered. The topics discussed include the variational principles of dynamics and optics, the analog between the mechanical and optical principles, significance of the wave function, the problems of the wave equation, and Schrödinger matrices for the representation of physical quantities. Also discussed are experimental evidence of the wave-like character of matter, angular momentum, and the first-order equation of quantum theory. (J.F.P.)

Electromagnetic

Refer also to abstract 1454.

1402 (JINR-P4-3450) PRAVILA SUMM I γd RASSEYANIE VPERED. (Sum Rules in γd Forward Scattering). Levin, K.; Robashik, D. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1967. 9p. (In Russian). Dep.

For γd forward scattering a family of sum rules is obtained. Two of them are sum rules for the anomalous magnetic moment and the electric quadrupole moment of the deuteron. (auth)

1403 (SLAC-PUB-355) WHAT HAVE WE LEARNED ABOUT ELEMENTARY PARTICLES FROM PHOTON AND ELECTRON INTERACTIONS? Drell, S. D. (Stanford Linear Accelerator Center, Calif.). Sept. 1967. Contract AT(04-3)-515. 50p. (CONF-670923-2). Dep. CFSTI.

From 3rd International Symposium on Electron and Photon Interactions at High Energies, Stanford, Calif.

A review is given of electron and photon interactions used for determining elementary particle properties. Several problems are considered, and the main emphasis placed on meson (π) production. (J.F.P.)

1404 (TH-177) LA PRODUCTION DE eta ET LES ANALYSES EN DEPHASAGE DE LA DIFFUSION PI-NUCLEON. (Production of eta and Phase-shift Analysis of π-Nucleon Scattering). Mennessier, G. (Paris Univ., Orsay (France). Laboratoire de Physique Theorique et Hautes Energies). Dec. 1966. 19p. (In French). Dep.

An attempt is made to determine whether a resonance previously found in a phase shift analysis of elastic meson (π)–nucleon scattering might be consistent with experimental results for η production from mesons (π) and photons. Several properties deduced from the unitarity of the S-matrix which allows different ways of connecting the scattering amplitudes are discussed. Then an isobaric-type model for the production interactions $\pi + N \rightarrow \eta + N$ and $\gamma + N \rightarrow \eta + N$ is presented. (J.F.P.)

1405 (TH-210) PHOTON MESO-PRODUCTIONS AND ELECTROMAGNETIC COUPLINGS OF BARYONIC RESONANCES. Renard, F. M.; Renard, Y. (Paris Univ., Orsay (France). Laboratoire de Physique Theorique et Hautes Energies). July 1967. 35p. Dep.

The interest of reactions with the production of photons, meson + nucleon → γ + baryon, in particular for the determination of the electromagnetic couplings of the (M-N) resonances with charge zero and strangeness equal to zero or minus one. As illustrations the cases of the first N^{*0} resonances appearing in $\pi^- + p \rightarrow \gamma + n$ and of the Y^{*0} resonances appearing in $K^- + p \rightarrow \gamma + \Lambda$ are treated. It is shown how these reactions may be used to test the isospin properties of the electromagnetic interactions, the predictions of quark models, SU(3) symmetry and other models for the classification and for the electromagnetic couplings of the baryonic resonances. Lastly, the reactions with a deuteron target $M + d \rightarrow \gamma + B + N$ are shown to be particularly sensitive to the baryon-nucleon interactions. (auth)

1406 INTERNAL SYMMETRIES OF THE ELECTROMAGNETIC CURRENT: EXPERIMENTAL TESTS. Shaw, Graham (Rutherford High Energy Lab., Chilton, Eng.). Nucl. Phys., B3: 338-48(1967).

Recent results cast doubt on the internal symmetry properties of the electromagnetic current, and possibly even the charge independence of strong interactions. The experimental evidence on these topics is reviewed, and further tests are discussed. There is ample evidence for charge independence to an accuracy of 5–10%, but the $|\Delta I| \leq 1$ rule for electromagnetic interactions is essentially untested, and the evidence for the supposed SU(3) properties is also found to be weak. Several experiments are suggested. In particular, a study of π^0 photo- (or electro-) production from deuterium in the region of the N*(1236) resonance; a study of $\pi^- p$ radiative capture, also in the region of the first resonance; and measurements of the radiative decay widths of the $Y_1^*(1385)$ resonance. (auth)

1407 STRUCTURE OF THE NUCLEON IN BOOTSTRAP THEORY. Noga, M. (Comenius Univ., Bratislava). Czech. J. Phys., 17: 822-9(1967).

On the basis of the self-consistency theory and the bootstrap dynamics the $N \rightarrow \pi + N$ form factor with one nucleon off the mass shell is calculated in the static model. It is shown that this form factor is an analytic function with analytic properties prescribed by the postulates of S-matrix theory. In addition to the correct analytic properties the form factor fulfils the unitarity condition if and only if certain relations among the meson-baryon coupling constants and among the masses of the baryons are fulfilled. The required ratios of coupling constants are the same as those derived by Chew and by Abers et al., in their static bootstrap model. Moreover the new condition for the mass of Δ-resonance is obtained here. (auth)

1408 TOTAL ANNIHILATION CROSS SECTION OF ELECTRON–POSITRON PAIRS INTO HADRONS AT HIGH ENERGIES. Gribov, V. N.; Ioffe, B. L.; Pomeranchuk, I. Ya. (Inst. of Theoretical and Experimental Physics, Moscow). Yadern. Fiz., 6: 587-90(Sept. 1967). (In Russian).

Asymptotic behavior of the total cross section of the process $e^+ + e^- \rightarrow$ hadrons at high energies is investigated. It is shown that at large E we have $\sigma \sim \text{const}/E^2$, where E – is the energy of e^+ and e^- in c.m. system. (auth)

1409 DOUBLE-LOGARITHMIC ASYMPTOTICS OF BREMSSTRAHLUNG AT THE ELECTRON–POSITRON BACKWARD SCATTERING. Lipatov, L. N. (Ioffe Inst. of Physics and Tech., Leningrad). Yadern. Fiz., 6: 564-78(Sept. 1967). (In Russian).

The bremsstrahlung at high energy for various two-particle processes has been considered. It has been shown that the only case where the Poisson distribution for the probability of n-photons emission is absent, is the large-angle electron-positron scattering. Double-logarithmic asymptotics of bremsstrahlung amplitudes at e^+e^- backward scattering has been obtained summing double–logarithmic contributions from all the orders of perturbation theory. The possibility of experimental test of these results is discussed. (auth)

1410 RADIATION CORRECTIONS TO THE SCATTERING CROSS SECTIONS OF ELECTRONS IN COLLIDING BEAMS. Baier, V. N.; Fadin, V. S.; Khoze, V. A. (Novosibirsk State Univ., USSR). Yadern. Fiz., 6: 560-3(Sept. 1967). (In Russian).

Radiation corrections to the scattering cross section of electrons in colliding beams taking into account the hard photon emission have been considered. The expression for radiation corrections to the cross sections of electron scattering under the existing experimental conditions has been obtained within logarithmic accuracy. (auth)

1411 PRODUCTION OF PAIRS OF IDENTICAL MESONS IN ELECTRON–POSITRON COLLISIONS. Ereshchenko, S. K. (Moscow Physical-Technical Inst.). Yadern. Fiz., 6: 555-9 (Sept. 1967). (In Russian).

Angular distribution of pairs of identical mesons produced in electron-positron collisions is shown not to depend on the meson spin. The explicit form of the spin s meson current is given. The cases of s = 1,2 are studied. (auth)

1412 ISOBAR ELECTROEXCITATION. Ivanter, I. G. Yadern. Fiz., 6: 550-4(Sept. 1967). (In Russian).

Expressions for the electron-proton inelastic scattering cross

section were obtained. The experimental data analysis was performed from which the upper limits for form factors were obtained. It is shown that up to experimental errors the nonresonant part is absent at the energies corresponding to the small resonance mass (up to 1500 MeV) and the transition $q^2 \geq -8$ is due to only two resonances. (auth)

1413 ELECTROMAGNETIC MASS DIFFERENCES. Wick, G. C.; Zumino, B. (CERN, Geneva). Phys. Lett., 25B: 479-81 (Oct. 16, 1967).

The electromagnetic mass difference between the charged and the neutral pion is calculated using the method of phenomenological Lagrangians. For zero pion mass the result is convergent and in agreement with previous work. For finite pion mass, however, it is divergent. The divergence is discussed from the point of view of the algebra of fields. (auth)

1414 ON THE USE OF POLARIZED PHOTONS AS A TEST OF THE REGGE-POLE HYPOTHESIS IN HIGH ENERGY PHOTOPRODUCTION OF NEUTRAL MESONS. Donnachie, A. (Harvard Univ., Cambridge, Mass.). Phys. Lett., 25B: 477-9(Oct. 16, 1967). (HUX-2752-25).

It is shown that polarized photons may be used to test some of the assumptions in the Regge-pole explanation of high-energy photoproduction of neutral mesons. (auth)

1415 PION ELECTROMAGNETIC MASS DIFFERENCE FOR PHYSICAL PIONS. Gerstein, I. S. (Massachusetts Inst. of Tech., Cambridge); Lee, B. W.; Nieh, H. T.; Schnitzer, H. J. Contracts AT-(30-1)-2098; AT-(30-1)-3668(B). Phys. Rev. Lett., 19: 1064-7(Oct. 30, 1967). (MIT-2098-375).

The on-mass-shell electromagnetic mass difference $\mu_{\pi^+} + -\mu_{\pi^0}$ is computed in a model consistent with chiral-algebra constraints and partial conservation of axial-vector currents, and found to be logarithmically divergent. Some implications of this result are discussed. (auth)

Weak

1416 (IAE-1241) POLYARIZATSIONNYE EFFEKTY V PROTSESSAKH S UCHASTIEM NEITRINO VYSOKIKH ENERGII. II. (Polarization Effects in Processes with Participation of High-Energy Neutrinos. II). Lyul'ka, V. A. (Akademiya Nauk SSSR, Moscow. Institut Atomnoi Energii). 1966. 33p. (In Russian). Dep.

Polarization effects are examined in reactions induced by high-energy neutrinos, of the types $\bar{\nu} + p \rightarrow \Lambda + l^+$, $\bar{\nu} + p \rightarrow \Sigma^0 + l^+$ and $\bar{\nu} + p \rightarrow n + l^+$, where l is a lepton; therefore questions connected with different types of neutrino are not considered. The various possibilities of the use of polarized targets to study such processes are considered. (JPRS)

1417 (ITEF-471) O PREDELE PRIMENIMOSTI TEORII SLABOGO CHETYREKHFERMIONNOGO VZAIMODEISTVIYA. (The Limit of Applicability of the Weak Four-Fermion Interaction Theory). Shabalin, E. P. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Moscow. Institut Teoreticheskoi i Eksperimental'noi Fiziki). 1966. 11p. (In Russian and English). Dep.

The ratio of the vector constants of β- and μ-decay with consideration of radiational corrections for weak interaction is used to find the value of the limiting momentum up to which the weak interaction theory is valid. Using three different schemes of that theory (the Gell-Mann–Feynman theory modified by the requirement of muon charge conservation, the Cabibbo hypothesis, and CP-odd weak interaction) values of 490, 270, and 440 GeV respectively are obtained. (JPRS)

1418 (JINR-P2-3513) FENOMENOLOGIYA $K^0 \rightarrow 2\pi$ RASPADA I REGENERATSIYA K^0 MEZONOV. (Phenomenology of $K^0 \rightarrow 2\pi$ Decay and Regeneration of K^0 Mesons). Lapidus, L. I. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1967. 31p. (In Russian). Dep.

Phenomenology of the $K^0 \rightarrow 2\pi$ decay mode and the results of the regeneration and interference experiments on the investigation of the CP-invariance violation are discussed. The Bell and Steinberger's unitarity relation for K^0-decay in vacuum and the consequences following from this relation are considered. (auth)

1419 (TH-206) UNITARITY AND RADIATIVE DECAY PROCESSES. Gaillard, M. K. (Paris Univ., Orsay (France). Laboratoire de Physique Theorique et Hautes Energies). July 1967. 24p. Dep.

Thesis.

By means of the unitary condition, the contribution of radiative $\pi\pi$ scattering to the matrix elements for radiative decay processes such as $K \rightarrow 2\pi\gamma$ are studied. In particular, the final state interaction phases associated with direct emission (as distinguished from bremstrahlung) amplitudes in radiative decays depend on the importance of the corresponding direct emission amplitudes in radiative scattering. The cases of T-invariance and T-violation are considered separately assuming CPT invariance throughout. In the limit of T-invariance it is found that the phase of a direct emission amplitude corresponding to a final state dipion system of angular momentum l is just the appropriate $\pi\pi$ scattering phase shift δ_l in the following cases: 1) The corresponding amplitude is forbidden in radiative scattering (e.g. magnetic emission for all l in spin-zero boson decays), and 2) The nonradiative decay is forbidden (e.g. η-decay and K_2^0 decay). For $K^\pm$ decay the nonradiative decay is suppressed relative to direct emission by the $|\Delta I| = 1/2$ rule; hence the approximation of a phase δ_l for electric as well as magnetic amplitudes may be reasonable. For the case of T-violation, the partial wave amplitudes $D_l(\bar{D}_l)$ for direct emission in radiative $K(\bar{K})$ decay into a final dipion state of angular momentum l are related by $\bar{D}_l = \pm D_l^\dagger \exp(2i\delta_l)$ if condition 1) or 2) above holds. Also the case in which these conditions do not hold is considered. It is found that CP violating effects such as a difference in rates and spectra for radiative K^+ and K^- decays, or an interference between K_L and K_S amplitudes remain nonvanishing in the latter case. (auth)

1420 (TH-211) ON THE q^2 DEPENDENCE OF THE K_{l3} FORM FACTORS. d'Espagnat, B.; Gaillard, M. K. (Paris Univ., Orsay (France). Laboratoire de Physique Theorique et Hautes Energies). July 1967. 6p. Dep.

The Fubini–Furlan method is applied to the problem of the q^2 dependence of the K_{l3} form factors. It is shown that if $f_+(q^2)$ varies slowly then a rapid variation of $f_-(q^2)$ can reasonably be expected. Possible means of extracting theoretical information from data on $f_-(q^2)$ are briefly discussed. (auth)

1421 A MODEL OF WEAK INTERACTIONS AND APPLICATION TO THE π- AND K-MESON DECAYS. Tsai, S. Y. (Nihon Univ., Tokyo). Progr. Theor. Phys. (Kyoto), 38: 417-30(Aug. 1967).

A possible model of weak interactions, which is capable of describing both of the semileptonic and nonleptonic decays consistently, is proposed and is applied to the π- and K-meson decays. Modified hadronic currents are introduced, each of which is the sum of a vector current and an axial vector current having their respective phase factors. It is suggested that the weak interactions are universal in the sense that the pure-leptonic, semileptonic and nonleptonic processes are describable with a common effective coupling constant. The origin of the fact that a significant violation of the $\Delta I = \frac{1}{2}$ rule is observed in the $K \rightarrow 2\pi$ mode but not in the $K \rightarrow 3\pi$ mode is shown to be related to the fact that $\Delta\theta \equiv \theta_A - \theta_V \neq 0$, where θ_V and θ_A are two Cabibbo angles characteristic of the vector and axial vector currents respectively. By generalizing the nonleptonic interaction so as to allow the CP violation, the amplitude ratio of the $K_L^0 \rightarrow \pi\pi$ mode to the $K_S^0 \rightarrow \pi\pi$ mode is also discussed. (auth)

1422 ON NONLEPTONIC DECAYS. INTERRELATION AMONG VARIOUS TYPES OF EFFECTIVE WEAK INTERACTIONS. Fujii, Kanji; Imoto, Mitsuo; Kawasaki, Shoichiro; Furui, Shin-ya; Tsuchida, Tetsuya (Tokyo Univ.). Progr. Theor. Phys. (Kyoto), 38: 388-416(Aug. 1967).

The interrelation among effective weak Yukawa interactions and various types of two-body weak interactions is discussed, and the refinement of the pole approximation is given. For this purpose, relations among three assumptions are investigated. Assumption I proposed by Fujii and Terazawa leads to the soft-meson theorem, owing to which one can relate the strong scattering amplitudes (the strong vertices) to the weak vertices (the effective two-body weak interactions), and octet-spurion formalism and tadpole model are derived. The decuplet-baryon-pole contributions to the hyperon decays are estimated in accordance with Assumption I and are shown to be relatively small. The relation of the effective two-body tranaition defined by using appropriate neutral currents $j_\alpha^{(7)}$ and $j_{5\alpha}^{(7)}$ (Assumption II) to the scalar- and pseudoscalar densities is discussed. It is shown first that the effective two-body transition derived from Assumption II can be regarded as approximately proportional to the scalar- and pseudoscalar densities with appropriate SU(3)-transformation properties, and secondly that, using the F-type vector current, one can obtain favorable values for the ratios of coupling constants of the effective two-body weak transition. In the framework of the pole approximation, when one combines Assumption I (or Assumption III—approximate Goldberger-Treiman relation) with Assumption II one can obtain the relations derived from Assumption III (or I). As a result, it is shown that the relation $A_V(n) \approx d \cdot A_S(n) \approx e \cdot A_B(n)$ holds for any n (decay mode) and ξ (F/D-ratio of strong meson-baryon ps(ps) interaction) $\approx (0.5 \sim 0.6)$, where $A_V(n)$, $A_S(n)$ and $A_B(n)$ mean the S-wave hyperon decay ampli-

tudes due to the K*-, $\bar{\kappa}$- and baryon-poles, respectively, and d and e are constants. Numerical values of d and e and the scalar (pseudoscalar) spurion coupling, $\langle\kappa\rangle_0(\langle K\rangle_0)$, depend upon the model of S-wave meson-baryon scattering. The inequality $(\langle\kappa\rangle_0)^2 \gg (\langle K\rangle_0)^2$ holds generally, irrespective of the magnitude of S-wave damping. Without the S-wave damping, one cannot reproduce the $K_1^0 \to 2\pi$ probability in the framework of meson-pole approximation. (auth)

1423 THE DECAYS $K \to \pi\gamma\gamma$ AND $K^+ \to \pi^+\pi^0$ IN THE η-POLE APPROXIMATION. Faldt, G.; Petersson, B.; Pilkuhn, H. (Univ. of Lund, Sweden). Nucl. Phys., B3: 234-40(1967).

Using a width of 1 keV for the decay $\eta \to \gamma\gamma$, the contribution of the η-pole to the decay $K^+ \to \pi^+\gamma\gamma$ is calculated. The decay $K_1^0 \to \pi^0\gamma\gamma$ is related to the decay $K_1^0 \to \gamma\gamma$ through the branching ratio $\Gamma(\eta \to \pi^0\gamma\gamma)/\Gamma(\eta \to \gamma\gamma)$. It is also shown that the electromagnetic $\pi^0\eta$ mixing can account for the decay $K^+ \to \pi^+\pi^0$. (auth)

1424 LIMIT OF APPLICABILITY OF THE WEAK FOUR-FERMION INTERACTION. Shabalin, E. P. (Inst. of Theoretical and Experimental Physics, Moscow). Yadern. Fiz., 6: 547-9 (Sept. 1967). (In Russian).

From the ratio of the vector constants of β- and μ-decays, taking into account radiation corrections due to weak interactions, the limiting value of momenta up to which the weak interaction theory is valid has been obtained. (auth)

1425 ON POSSIBLE EXPERIMENTAL MANIFESTATIONS OF (V + A) CURRENTS IN THE WEAK INTERACTIONS OF ELEMENTARY PARTICLES. Lipmanov, E. M. (Volgograd Pedagogical Inst., USSR). Yadern. Fiz., 6: 541-6(Sept. 1967). (In Russian).

The arguments in the favor of (V + A)-currents in the weak interaction of elementary particles are given. It is shown that the accuracy of the experimental data presently achieved, when measuring the spectrum, polarizations and cross sections for leptonic (μ-decay) and semileptonic (π-decay, neutron β-decay, the high energy neutrino experiments) of the weak processes which in a series of cases is of a percent, does not exclude the admixture of (V + A)-coupling at the level of 10%, since in the most cases (V – A)- and (V + A)-couplings do not interfere with each other. Some experimental possibilities to observe hypothetical leptonic charged (V + A)-currents in the weak interactions are shown. (auth)

Strong (General)

Refer also to abstract 1488.

1426 (JINR-E2-3511) ON THE DISPERSION SUM RULES IN THE THEORY OF STRONG INTERACTIONS. Solov'ev, L. D. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1967. 23p. (CONF-670824-2). Dep.

From International Theoretical Physics Conference on Particles and Fields, Rochester, N. Y.

Problems of applications and main results of the dispersion sum rules based on superconvergence and on the Regge pole hypothesis are considered. (auth)

Strong (Baryon No. = 0)

Refer also to abstract 1419.

1427 (JINR-E2-3454) SYMMETRY BREAKING QUASIPARTICLE METHOD FOR BARYONS AND FOR QUARKS. II. RESONANCE SCATTERING PROBLEM. Wohlrab, K. S. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1967. 28p. Dep.

The resonance scattering of those particles, which were described previously as bound states of baryons or quarks with the help of the quasiparticle approximation is treated. Simple interactions between physical particles are written down, and a finite nonperturbational renormalization of 4-fermion interactions results. So this method disentangles the problem of resonances from the divergency problem. The K- and S-matrix for resonance scattering is calculated, leading to a Breit-Wigner formula with resonances just at the masses of those physical particles (resonances), which are possible intermediate states of the scattering process. The method shows interesting connections with polylocal fields and with the Newton–Wigner localization problem. (auth)

1428 GOLDBERGER–TREIMAN RELATION AND THE ELEMENTARITY OF THE PION. Kinoshita, Kisei (Tokyo Univ.). Progr. Theor. Phys. (Kyoto), 38: 460-71(Aug. 1967).

After an argument to fix an arbitrary parameter characteristic of the pseudoscalar pion theory, the relation between the charged pion decay and the nucleon β-decay is discussed in connection with the elementarity of the pion, within the framework of the elastic unitarity model of n-$\bar{p}$ scattering. The form factor and the vertex function for the pion decay are expressed in compact forms in terms of the pion propagator and Z(s). When the pion is elementary, the unsubtracted dispersion relation holds for the β-decay amplitude of n-$\bar{p}$ pair in the $^1S_0$ state, even if the proportionality $\langle n\bar{p}|\partial_\lambda J_\Lambda^\lambda|0\rangle \propto \langle n\bar{p}|\phi_\pi|0\rangle$ is not satisfied. The relations obtained from the proportionality hypothesis and from the unsubtracted dispersion relation for the decay vertex coincide with each other when Z_3 of the pion tends to zero. (auth)

1429 LOW-ENERGY $\pi-\pi$ SCATTERING. Antoniou, N. G.; Smith, C. H. Llewellyn (Oxford Univ.). Nucl. Phys., B3: 277-90(1967).

The forward $\pi-\pi$ dispersion relations for T = 0 and T = 2 in a soluble model are considered. The model is based on two assumptions. The $\pi-\pi$ cross section has the same constant asymptotic value for all isobaric states (Pomeranchuk theorem). The forward amplitude becomes purely imaginary at infinite energies. For simplicity only cases with one or no CDD pole in each isobaric state are considered. Two solutions which are consistent with the constraints of crossing are found. Solution A has a T = 0, CDD pole, the T = 0 scattering length $(a_0) = -0.8$, the T = 2 scattering length $(a_2) = -0.4$. Solution B has a T = 0 and a T = 2, CDD pole, $a_0 \approx +1$, and $a_2 \cong 0$. There is an S-wave resonance in the region $3m_\pi$ to $8m_\pi$ for T = 0. Solution B is in qualitative agreement with the experimental evidence. (auth)

1430 THE D_{13} COUPLING CONSTANT. Alam, M. A.; Roberts, R. G. (Durham Univ., Eng.). Nucl. Phys., B3: 192-4(1967).

The values for the coupling constant $g_{Dp\pi}$ derived from two methods are compared. The two methods are based on a superconvergence relation for πD_{13} scattering and the axial-vector coupling constants derived by Gatto, Maiani and Preparata. (auth)

1431 ON THE ENERGY DEPENDENCE OF THE EFFECT ON ANGULAR CORRELATIONS IN $p\bar{p}$ ANNIHILATIONS. Czyzewski, O. (Inst. of Nuclear Research, Krakow); Szeptycka, M. Phys. Lett., 25B: 482-5(Oct. 16, 1967).

It is shown that the dependence of the angular correlations of G. Goldhaber et al. type on the average pion energy is of the exponential form. (auth)

1432 SUM RULES FOR $\pi\pi$ AND πN SCATTERING. Orlov, I. I.; Shirkov, D. V. (Inst. of Mathematics, Novosibirsk, USSR). Yadern. Fiz., 6: 638-44(Sept. 1967). (In Russian).

The sum rules for the $\pi\pi$-scattering previously obtained on the basis of the Mandelstam representations are shown to be deduced from the strictly proved dispersion relations on a at t fixed. The corresponding sum rules for the πN-scattering are found to be equivalent to the sum rules considered by Hamilton and Woolcock. (auth)

1433 $A_1 \to \rho\pi$ AND $\rho \to 2\pi$ DECAYS. Das, T.; Mathur, V. S.; Okubo, S. (Univ. of Rochester, N. Y.). Contract AT-(30-1)-875. Phys. Rev. Lett., 19: 1067-70(Oct. 30, 1967). (UR-875-211).

An analysis of the A_1 and the ρ decays is made using current algebra, partial conservation of axial-vector currents, and dispersion relations; the pions are treated as "soft" in the sense $K^2 \to 0$ instead of $K \to 0$ which is usually assumed. (auth)

Strong (Baryon No. = 1)

Refer also to abstracts 1404, 1405, and 1432.

1434 (AD-646614) RESONANCE POLES IN A SIMPLE MODEL OF S WAVE PSEUDOSCALAR MESON BARYON SCATTERING. Logan, R. K.; Wyld, H. W. (Illinois Univ., Urbana. Dept. of Physics). 1966. Contract NSF-GP-6198. 17p. CFSTI.

A numerical calculation was previously made of S wave pseudoscalar meson baryon scattering in a simple broken SU(3) model based on a static vector meson exchange potential and coupled channel Schrödinger equation. These calculations are extended to finding the location of the poles of the scattering matrix in the multisheeted complex energy plane and the motion of these poles as the strength of the potential is varied. Particular attention is paid to the behavior of the poles when the potential strength is such that there is a resonance close to a threshold. (auth)

1435 A REMARK ON THE EFFECT OF HIGHER $\pi-N$ RESONANCES ON THE $\pi\pi \to N\bar{N}$ AMPLITUDE. Furuichi, Susumu; Sokawa, Toru (Rikkyo Univ., Tokyo). Progr. Theor. Phys. (Kyoto), 38: 516-18(Aug. 1967).

The contribution from the higher $\pi + N$ resonances to the $\pi + \pi \to N + \bar{N}$ helicity amplitudes is examined explicitly, extending the CGLN formula for the $\pi + N$ scattering beyond the 3-3 approximation. It is concluded that the contributions from the πN resonances

heavier than the 3-3 resonance to $L \geq 2$ states are negligibly small at least for $t < 100\ \mu^2$, where μ is the meson (π) mass. Also in the $L = 0$ state the higher πN resonances also contribute a large amount in addition to the contributions from the nucleon pole and the 3-3 resonance. However, S-wave resonances contribute very little even for the $L = 0$ state. (J.F.P.)

1436 HELICITY COUPLING CONSTANT. Iwasaki, Yoichi (Tokyo Univ.). Progr. Theor. Phys. (Kyoto), 38: 472-5(Aug. 1967).

Introducing the helicity coupling constant, it is shown that one can easily calculate scattering amplitudes and decay probabilities of processes involving arbitrary spin, only by multiplying the helicity coupling constants. (auth)

1437 STRONG DECAYS OF BARYONS. Nagai, Hideaki (Hiroshima Univ.). Progr. Theor. Phys. (Kyoto), 38: 449-59 (Aug. 1967).

A model of the baryon composed of three fundamental triplets (q) which move independently in an effective potential is adopted. The wave function of the baryon is prepared in a way similar to the case of interpreting the mass levels of baryons. The strong decay probability of all baryon resonances is calculated under the above model and the result is compared with the observed one by assuming both a static $qq\phi$-interaction (ϕ is an octet ps-meson) and no exchange current. The possibilities of assigning the low-lying resonance levels to a unitary multiplet different from that described are also discussed. (auth)

1438 BACKWARD π^+p SCATTERING AND THE Y = 1 FERMION REGGE POLE HYPOTHESIS. Yamamoto, Yoshitaka (Tokyo Univ.). Progr. Theor. Phys. (Kyoto), 38: 382-7(Aug. 1967).

The backward π^+p scattering is analyzed using the Regge pole hypothesis of a nucleon and π-N resonances. The residue function is determined from the resonance parameters (mass, width and elasticity). Qualitative agreement with experiment is obtained. In particular the difference between the π^+p and π^-p scattering is explained. (auth)

1439 INELASTIC MESON–BARYON SCATTERING WITH REGGE POLES AND SU_3 SYMMETRY. Salin, Ph. (CERN, Geneva). Nucl. Phys., B3: 323-37(1967).

Inelastic meson-baryon scattering of type $0^- + 1/2^+ \rightarrow 0^- + 1/2^+$ is studied on the basis of Regge poles and exact SU_3 symmetry. The exchanged trajectories considered are ρ, A_2, $K^*(890)$ and $K^{**}(1411)$. Good agreement is obtained for the differential cross section in the forward direction for different reactions. The f/d ratio is found to be –11 for the 1^- octet and 0.25 for the 2^+ octet. (auth)

1440 SHORT-WAVE CONTRIBUTIONS IN THE LOW-ENERGY πN SCATTERING. Lend'el, V. I.; Serebryakov, V. V.; Shirkov, D. V. (Inst. of Mathematics, Novosibirsk, USSR). Yadern. Fiz., 6: 625-34(Sept. 1967). (In Russian).

High-energy contributions into the low-energy πN-scattering is considered semiphenomenologically. It has been shown that this consideration leads to the expressions for s- and p-waves differing from the Chew–Goldberger–Low–Nambu formulas by the terms of form factor type. Plausible choice of parameters allows a good agreement with the experimental data for the scattering widths and for energetic dependences. A part of form factors corresponds to the contributions of $\pi\pi$–$N\bar{N}$-channel and can be identified with the masses of ρ- and σ-mesons. (auth)

1441 DETERMINATION OF THE BARYONIC CURRENT STRUCTURE FROM DISPERSION RELATIONS. Granovskii, Ya. I.; Starikov, V. N. (Inst. of Nuclear Physics, Alma-Ata, USSR). Yadern. Fiz., 6: 610-13(Sept. 1967). (In Russian).

Analysis of experimental data by means of dispersion relations made it possible to determine the constants characterizing the baryonic current structure: D = –0.52, F = –0.35. The coupling constants of K-meson with hyperon have been as well obtained: $g^2_{K\Lambda N}/4\pi = 5.9 \pm 1.3$; $g^2_{K\Sigma N}/4\pi = 0.4^{+0.3}_{-0.4}$. (auth)

1442 ABSORPTION OF S-ORBIT π^- MESONS BY ^{4}He. Koltun, Daniel S.; Reitan, Arne (Norges Tekniske Hoegskole, Trondheim, Norway). Ark. Fys. Seminar Trondheim, No. 11, 23p. (1967).

The rate for absorption of s-orbit bound π^- mesons by correlated nucleon pairs and the distributions in momentum and laboratory angle of the emitted fast nn or np pair are calculated for ^{4}He. The pion is assumed to be absorbed either directly by one nucleon, or by processes that involve exchange of the absorbed pion between the two nucleons in question. The absorbing nucleon pair is assumed to interact in the initial state through a harmonic-oscillator potential plus a short-range (Hamada-Johnston) interaction, and in the final state only through the short-range interaction. (auth)

1443 METHOD FOR $\pi\pi$ OR Kπ PHASE-SHIFT ANALYSIS. Schlein, Peter E. (Univ. of California, Los Angeles). Phys. Rev. Lett., 19: 1052-6(Oct. 30, 1967).

It is pointed out that the $\pi\pi$ phase shifts may be extracted from the data (at least in the region of the ρ resonance) without complete prior knowledge of the helicity amplitudes in the reaction $\pi^- + p \rightarrow \pi^- + \pi^+ + n$ using therefore only a subset of the assumptions used in the absorption model all of which may be subjected to test. Furthermore, it is shown below that for data in a sufficiently narrow band of total cms energy and production angle (or momentum transfer to the nucleon) in the reaction studied, empirical values of the helicity amplitudes may be extracted from the data. These arguments apply equally to the reaction $\pi^+ + p \rightarrow \pi^+ + \pi^- + N^{*++}$ and to the determination of the Kπ phase shifts in the $K^*(890)$ region if the π-exchange dominated reaction $K^+ + p \rightarrow K^+ + \pi^- + N^{*++}$ is used. (J.F.P.)

1444 $\pi\pi$ PHASE-SHIFT ANALYSIS FROM 600 TO 1000 MeV. Malamud, Ernest; Schlein, Peter E. (Univ. of California, Los Angeles). Phys. Rev. Lett., 19: 1056-61(Oct. 30, 1967).

An analysis of the $\pi\pi$ elastic scattering phase shifts is presented for $\pi\pi$ effective mass $0.6 < m_{\pi\pi} < 1.0$ GeV and $\cos\theta_{cm} > 0.9$ (nucleon momentum transfer $t \lesssim 0.175$ GeV^2), using a sample of data with beam momenta 2.1 to 3.2 GeV/c for the interactions $\pi^- + p \rightarrow \pi^- + \pi^+ + n$ (6740 events) and $\pi^- + p \rightarrow \pi^- + \pi^0 + p$ (3656 events). The detailed analysis described for these interactions is used to obtain independent information of the T = 2 S-wave interaction. Aside from demonstrating that the data satisfy well the tests suggested previously, the T = 0 S-wave phase shift is shown to increase from about 60 to about 90° in the range $600 < m_{\pi\pi} \lesssim 730$. For 730 MeV < $m_{\pi\pi}$ this phase shift probably continues to increase, implying the existence of a T = 0 scalar meson $\sigma(730)$. (J.F.P.)

1445 MULTICHANNEL PHASE-SHIFT ANALYSIS OF $\bar{K}N$ INTERACTION IN THE REGION 0 TO 550 MeV/c. Kim, Jae Kwan (Yale Univ., New Haven). Phys. Rev. Lett., 19: 1074-8(Oct. 30, 1967).

A multichannel phase shift analysis was performed on available experimental data for all channels of $K^- + p$ and $K^0_1 + p$ interactions in the momentum interval from 0 to 550 MeV/c. In this analysis, a previous multichannel effective-range parametrization was applied. The results on the S_{01} phase shift give the mass and width of the $\bar{K}N$ bound state which are, respectively, lower and larger than the values obtained from the previous constant-scattering-length analysis. The P_{13} phase shift shows that $Y_1^*(1385)$ is due mainly to the strong $\Lambda\pi$ interaction and that its coupling to $\bar{K}N$ is very weak. Also in this analysis the Fermi–Yang ambiguity in a previous $I = 0$ $K^+ + n$ phase shift can be resolved, and the Yang set is definitely favored. (J.F.P.)

1446 CUT-OFF PARAMETER IN $\pi\pi$ INTERACTION. Wolf, J.; Zoellner, W. (Humboldt-Univ., Berlin). Monatsber. Deut. Akad. Wiss. Berlin, 9: 174-8(1967). (In German).

Subtraction-free dispersion relations were employed for a self-consistent calculation of the p-wave of $\pi\pi$ scattering inverse amplitudes. For the left-side cut, a theorem was presented that is determined from the crossing symmetry and bootstrap conditions. For the definition of the partial waves of $\pi\pi$ scattering, a start was made from the differential approximation described by EFREMOV, A. V., et al., in Nucl. Physics, Vol 22, 1961, p. 202. (JPRS)

1447 PHENOMENOLOGY OF $\pi N \rightarrow \pi N^*$ BELOW 1 GeV. Roberts, R. G. (Univ. of Durham, Eng.). Ann. Phys. (N. Y.), 44: 325-35(1967).

The angular distribution for the production reaction $\pi N \rightarrow \pi N^*$ at energies below 1 GeV is investigated in terms of the familiar Legendre series expansion. By incorporating results from pion–nucleon phase-shift analysis it is shown that the most probable dominant inelastic decays of three pion–nucleon resonances are $D_{13}(1520) \rightarrow N^*(1238) + \pi$, $D_{15}(1650) \rightarrow D_{13}(1520) + \pi$, and $F_{15}(1670) \rightarrow D_{13}(1520) + \pi$. (auth)

1448 DETERMINATION OF NΛK AND NΣK COUPLING CONSTANTS. Kim, Jae Kwan (Yale Univ., New Haven). Phys. Rev. Lett., 19: 1079-81(Oct. 30, 1967).

Using KN forward dispersion relations, both the NΛK and NΣK coupling constants were determined: $g_{p\Lambda K^+}^2 = 16.0 \pm 2.5$ and $g_{p\Sigma^0 K^+}^2 = 0.3 \pm 0.5$. The results are consistent with SU(3) invariance for baryon–baryon–pseudoscalar meson coupling constants. The value of the F–D mixing parameter obtained from these coupling constants for strong interactions agrees with the value obtained from the Cabibbo theory and weak hyperon decay experiments. (J.F.P.)

1449 DISPERSION RULES OF SUMS IN A STATIC MODEL. Pisarenko, V. G. (Joint Inst. of Nuclear Research, Dubna, USSR). Dokl. Akad. Nauk SSSR, 175: 331-3(July 11, 1967). (In Russian).

Dispersion sum rules for a static model were obtained using

certain assumptions on the behavior of the amplitude of π-meson elastic scattering on nucleons and the amplitude of the virtual photoproduction of π mesons on nucleons. The existence of static limitation for dispersion sum rules was established on the basis of the static limitation in dispersion relations obtained for the πN scattering and for virtual photoproduction of π mesons on nucleons. (R.V.J.)

Strong (Baryon No. ≥ 2)

Refer also to abstract 1405.

1450 (AD-648017) PARTICLE NUCLEUS INTERACTIONS AND THE REGGE MODEL. James, P. B.; Logan, R. K.; Watson, H. D. D. (Illinois Univ., Urbana. Dept. of Physics). 1966. Contract NSF-GP-6198. 13p. CFSTI.

It is proposed that the Regge pole model may be applied to the high energy scattering of particles (pion, K,N) by nuclei. The deuteron total cross sections are shown to be consistent with this hypothesis. (auth)

1451 ANALYSIS OF NUCLEON-NUCLEON SCATTERING WITH LARGE MOMENTUM TRANSFERS. Nagasaki, Masayuki; Hirasawa, Toshiaki; Taketani, Mituo (Rikkyo Univ., Tokyo). Progr. Theor. Phys. (Kyoto), 38: 514-16(Aug. 1967).

The Serber model, which is based on an approximation for the amplitude of waves scattered from a soft medium at forward directions, is discussed. The scattering amplitude for the Klein-Gordon equation is considered. (J.F.P.)

1452 DYNAMICAL STATISTICAL MODEL OF HIGH ENERGY ELASTIC SCATTERING. Namiki, Mikio; Ohba, Ichiro (Waseda Univ., Tokyo). Progr. Theor. Phys. (Kyoto), 38: 431-48(Aug. 1967).

High energy elastic scattering is discussed through a proposal of the "dynamical statistical model," in which large angle elastic scattering at high energies is considered to be caused by some sort of irreversible process taking place in the inner system of colliding nucleons. The "dynamical statistical model" enables one to obtain both the rapid decrease of the differential cross section for increasing energy and the small fluctuation of the scattering amplitude, for the large angle elastic scattering at high energies. After a few manipulations, it is shown that the model can derive the differential cross section proportional to $\exp(-\alpha p_\perp)$ similar to Orear's empirical formula for large $p_\perp$, α and $p_\perp$ being, respectively, the Orear constant and the transverse momentum. The present model also gives the relation between the the exponential $p_\perp$-dependence for large $p_\perp$ and the Gaussian $p_\perp$-dependence for small $p_\perp$ within a unified theoretical framework, from which follows $\alpha^{-1} \geq 0.158$ M, M being the nucleon mass. This is in good agreement with experiment. Furthermore it is remarked that the present model has the possibility of deriving, even for large $p_\perp$, the Gaussian $p_\perp$-dependence like Krisch's empirical formula in some extreme cases, which may not be obtained by the simple statistical model given by Hagedorn and others and by the unitarity-analyticity argument. The irreversibility of the large-angle scattering—to be realized even by the time-reversal invariant Hamiltonian—does not permit one to impose the time-reversal invariance requirement and the simple unitarity-analyticity argument on the large angle scattering amplitude except on the forward amplitude. Its consequence may be used for a crucial test of the model. The "dynamical statistical model" was built on the basis of critical discussion against the simple statistical model. For this reason a detailed discussion of the latter is given. (auth)

1453 TWO-PION EXCHANGE CONTRIBUTION TO THE NUCLEON-NUCLEON POTENTIAL. Kapadia, P. D. (University Coll., London). Nucl. Phys., B3: 291-311(1967).

The low energy scattering of two nucleons is studied within the framework of dispersion theory, using the Mandelstam representation. Certain ρ-functions occur in the treatment of this problem and these ρ-functions are expressed in terms of the helicity amplitudes for the process $2\pi \rightarrow N\bar{N}$ for any value of the angular momentum J. These ρ-functions are evaluated using the BCL model and using the "realistic" helicity amplitudes for the S- and P-waves for the process $2\pi \rightarrow N\bar{N}$. Next, going over to the potential approximation, the two-pion contribution to the nucleon-nucleon potential was evaluated. In the nucleon-nucleon potential, as calculated by Cottingham and Vinh Mau, the BCL S- and P-wave model-dependent contributions are replaced by the corresponding S- and P-wave contributions calculated using the realistic helicity amplitude data for the process $2\pi \rightarrow N\bar{N}$. The nucleon-nucleon potentials so obtained in the various cases, such as the central potential, the spin-orbit potential, etc., are described graphically by curves for both the triplet and singlet states. The various ρ-functions obtained are also illustrated graphically and a critical discussion of the work is included. In conclusion, it is observed that the nucleon-nucleon potential calculated agrees with that calculated by Cottingham and Vinh Mau and with the Yale curves for the potential, except in special cases where the ω meson is expected to contribute strongly. (auth)

1454 PROTON-PROTON BREMSSTRAHLUNG. Pearce, W. A.; Gale, W. A.; Duck, I. M. (Univ. of Rice, Houston, Tex.). Nucl. Phys., B3: 241-76(1967).

Proton-proton bremsstrahlung cross sections are calculated using the Tabakin separable potentials to generate off-shell nucleon-nucleon t-matrix elements in low partial waves and off-shell one-pion-exchange amplitudes for the higher partial waves. The results are in good agreement with the experimental values reported by Warner, Halbert, Gottschalk and Thorndike at proton bombarding energies of 48, 62, 158 and 204 MeV, but are at the lower limit of the experimental results of Warner at 30 MeV and of Slaus at 46 MeV. The calculated cross sections in the Harvard geometry decrease monotonically to zero at zero proton energy. The effect of rescattering corrections and of nonlocal corrections to the bremsstrahlung amplitude were estimated and these terms were found to be negligible for proton-proton bremsstrahlung. The results are insensitive to the choice of Tabakin's "soft-core" or "hard-shell" $^1S_0$ potential, and are insensitive to small changes in the P-wave potentials. (auth)

1455 BOUND ON THE DOUBLE SPECTRAL FUNCTION FOR A CLASS OF YUKAWIAN POTENTIALS. Bertero, M.; Kreuzer, H. J. (Univ., Bonn). Nucl. Phys., B3: 195-206(1967).

A simplified proof of a bound for the double spectral function as derived by Bessis is presented. The class of Yukawian potentials for which the proof holds contains the class of Bessis and also the pure Yukawa potential. The bound for the double spectral function implies that the repeated integral in the Mandelstam representation exists (i.e., it is really a double integral). (auth)

1456 INFLUENCE OF THE ππ-NN̄ INTERACTION UPON THE NUCLEON-NUCLEON SCATTERING. Lend'el, V. I.; Ernst, B. M. (Uzhgorod State Univ., USSR). Yadern. Fiz., 6: 614-24(Sept. 1967). (In Russian).

The amplitude of the nucleon-nucleon scattering is expressed via the parameters of the πN and ππ-interactions. The constants of the ρ, σ and ω meson-nucleon couplings are obtained on basis of the differential approach. The partial amplitudes of the NN-interaction are described reasonably with these constants. (auth)

1457 PROTON-PROTON SCATTERING AT HIGH ENERGY AND LARGE ANGLES AND THE THEORY OF THE COMPLEX ANGULAR MOMENTA. Ansel'm, A. A.; Dyatlov, I. T. (Ioffe Inst. of Physics and Tech., Leningrad). Yadern. Fiz., 6: 603-9 (Sept. 1967). (In Russian).

Proton-proton scattering at high energy and large momentum transfer are discussed in view of the complex angular momenta. It is shown that the available experimental data are in good accordance with the predictions based on the calculations of the contribution from the Mandelstam branch points in the angular momentum plane. A picture is proposed to explain the change of the character of the momentum transfer dependence of the cross section at large angles. (auth)

Particle Invariance Principles and Symmetries

General

1458 (NP-17076) FOUR-DIMENSIONAL SPACE WITH $SU(3)/Z_3$ SYMMETRY. DARL Research Communication No. 31. Pandres, Dave Jr. (Douglas Aircraft Co., Inc., Huntington Beach, Calif. Advanced Research Lab.). May 1967. 13p. Dep.

The lowest dimensional Riemann space which admits $SU(3)/Z_3$ as its group of motions is obtained. This is a real four-dimensional compact Einstein space with positive-definite metric. The metric and the imbedding of the space into the eight-dimensional group space are given explicitly. (auth)

1459 (TID-24095) NON-DYNAMICAL TESTS OF CONSERVATION LAWS IN PARTICLE REACTIONS. Lectures Given at the College of William and Mary, Williamsburg, Virginia. Moravcsik, Michael J. (Harvard Univ., Cambridge, Mass. California Univ., Livermore. Lawrence Radiation Lab.). Oct. 1966. Contracts W-7405-eng-48; AF49(638)-1380. 89p. Dep. CFSTI.

A summary is given of recent work to establish the properties of those experiments which, in the absence of any information about the forces acting between particles, can test the validity of various conservation laws and can determine the intrinsic

quantum numbers pertaining to these conservation laws in a particle reaction involving an arbitrary number of particles with arbitrary spins. Among the sixteen transformations discussed particular attention is paid to space reflection, time reversal, charge conjugation and CPT invariance. To illustrate the results, the special example of the four-particle reaction involving two particles with zero spin and two particles with unit spin is worked out in great detail. (auth)

1460 WIGNER COEFFICIENTS OF THE SU(3) GROUP FOR A PARTICULAR CASE OF IMPORTANCE IN PHYSICAL APPLICATIONS. Renero, Ignacio (Universidad Nacional de Mexico). Rev. Mex. Fis., 16: 89-104(1967). (In Spanish).

Wigner coefficients for the group SU_3 are tabulated in closed algebraic form. These coefficients correspond to the direct product of two representations labeled by the partitions (h_1', h_2') and (h_1'', h_2'') with arbitrary h_1' and h_2', but $h_1'' = 2$ and $h_2'' = 1$. In the most general case, one obtains 64 coefficients, labeled in the tabulation by indices h and q corresponding to the group SU_3 and its subgroup SU_2 respectively. The coefficients presented are normalized and follow Biedenharn's phase convention. The method of calculation, based on the concept of the auxiliary Wigner coefficient, is outlined. The use of the auxiliary Wigner coefficients enables one to handle properly the problem of nonsimple reducibility which appears in one of the cases considered. (auth)

1461 A NEW APPROACH TO THE SU(2) × SU(2) SYMMETRY OF THE KEPLER MOTION. Ravndal, F.; Toyoda, T. (Norges Tekniske Hoegskole, Trondheim, Norway). Nucl. Phys., B3: 312-22(1967).

By making use of squared parabolic coordinates, SU(2) × SU(2) symmetry of the Kepler motion is demonstrated in a straightforward way. Instead of starting from the Runge-Lenz-Pauli vector, the symmetry is derived in a natural manner, and a similarity between this approach and current algebra is pointed out. A remark on the treatment of symmetry problems in quantum mechanics and elementary particle physics is given. (auth)

1462 THE TENSOR PRODUCT OF ONE-PARTICLE REPRESENTATIONS OF AN INFINITE-DIMENSIONAL LIE ALGEBRA. Havlicke, M. (Czech Technical Univ., Prague); Votruba, J. Czech. J. Phys., 17: 809-21(1967).

The recently proposed infinite-dimensional Lie algebra as a model of a symmetry scheme is studied from the point of view of its representations. The tensor product of two one-particle representations of this algebra is constructed and the reduction problem is studied. A new series of representations having nonlinear mass formulas is found. Some physical consequences for two-particle states are also discussed. (auth)

1463 INVARIANCE AND ELEMENTARY PARTICLE THEORY. Konopleva, N. P.; Sokolik, G. A. pp 22-44 of Problemy Teorii Gravitatsii i Elementarnykh Chastits. Stanyukovich, K. P.; Sokolik, G. A. (eds.). Moscow, Atomizdat, 1966. (In Russian).

The possibilities of geometric interpretation of the prerequisites of the laws of conservation are examined, and it is concluded that any physically measurable field is defined by two classes of geometric characteristics, namely the fundamental symmetry, defining the region of applicability of a given theory on the basis of measurement, and the nonholonomy of universal space (in particular of Riemann and Bailey spaces), the points of which are spaces of the states of all possible instruments used in the given theory. The nonholonomy of the space identified with external four-dimensional space-time determines the reality of the studied field. (JPRS)

Applications (Electromagnetic and Weak)

1464 (N-67-22464) ISOTOPIC SPIN ANALYSIS OF POSSIBLE CP VIOLATING EFFECTS IN $K \rightarrow 3\pi$. Gaillard, M. K. (Paris Univ., Orsay (France). Laboratoire de Physique Theorique et Hautes Energies). Jan. 1967. 15p. (TH-181). Dep.

CP violating effects in the decay $K \rightarrow 3\pi$ are analyzed in terms of isotopic spin parameters. In particular, the interference term between K_S and K_L amplitudes, and the difference in partial rates in K^+ decay are considered. In general, the real part of the interference term is expected to be much smaller than the imaginary part for transitions with $|\Delta I| < 5/2$. The success of the $|\Delta I| = 1/2$ rule in K_L and K_S decay sets an upper limit on the imaginary part of the interference term for CP violating amplitudes with $|\Delta I| = 1/2$. This limit is probably too high to be useful, but a significant effect in the real part would probably indicate that amplitudes with $|\Delta I| > 1/2$ are important. This conclusion could be checked by comparing the real part of the interference term with the differences in partial rates in K^+ decay; the two effects are directly related through coefficients depending on $|\Delta I|$ and the isotopic spin of the final state. In K^0 decay, I = 1 final states ($|\Delta I| < 3/2$) may be distinguished from I = 3 final states ($|\Delta I| \leq 3/2$) by comparing the imaginary parts of the interference terms in the $\pi^+\pi^-\pi^0$ and the $3\pi^0$ modes. (auth)

1465 NEUTRAL K-MESON DECAY AND DISCRETE SYMMETRIES. Gourdin, M. (Faculte des Sciences, Orsay, France). Nucl. Phys., B3: 207-33(1967).

The decay of neutral K-mesons including the possibility of discrete symmetries such as total reflection TCP or time reflection T is studied. Then the available experimental results are analyzed and discussed. (auth)

Applications (Strong)

1466 (ITF-67-10) HIGHER ORBITAL STATES IN THE FRAMEWORK OF SYMMETRY THEORY. Kadyshevskii, V. G.; Muradyan, R. M. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1967. 26p. Dep.

The symmetry group SU(24) appearing in the Greenberg model (Phys. Rev. Lett., 13: 592(1964)) and relating to the group SU(6), $SU(3)_L$, O(3), etc. is studied by a reduction scheme. (J.F.P.)

1467 NOTE ON POINCARE GROUP EXTENSIONS AND INTERNAL SYMMETRY TRANSFORMATIONS. Hegerfeldt, G. C.; Kraus, K. (Univ., Marburg, Ger.). Nucl. Phys., B3: 189-91(1967).

The proposal of Michel to unify internal and space-time symmetries by group extension is shown to rest on an unphysical assumption: Contrary to what was assumed by Michel, internal symmetry transformations cannot be contained in the commutant A′ of the algebra A of observables. (auth)

1468 U_6 COMPOSITE MODEL. Aguilera Navarro, V. C.; Castilho Alcaras, J. A.; Leal Ferreira, P. (Instituto de Fisica Teorica, Sao Paulo). An Acad. Brasil. Cienc., 39: 49-58(Mar. 1967).

The composite model for baryons and resonances in terms of quarks with U(6) symmetry is treated in a nonrelativistic approximation by the method of second quantization envisaged previously for nuclear structure problems. This method has the merit of making explicit for the start the U(6) unitary symmetry properties of the system. Quarks are assumed to be quite massive interacting through forces whose ranges are larger than their Compton wavelength. These hypotheses justify the nonrelativistic treatment and neglect of the kinetic energy as compared with the much stronger interaction energy. Within the limitations of the present model and following the lines of Kuo and Radicati forces which are invariant under U(6) and those breaking this symmetry are introduced. It is shown that a suitable mixture of invariant two-body forces exists that makes the particles of the 56-dimensional representation of U(6). Next generalized-exchange two-body forces giving noninvariant contributions to the interaction energy are discussed. Forces necessary to given the general mass formula of Beg and Singh are exhibited. Using the theory of the irreducible tensor operators the states in the physical chain are constructed in a general way and specified for cases of physical interest. (J.F.P.)

1469 SYMMETRIES OF STRONG INTERACTIONS. Dallaporta, N. (Univ., Padua). pp 400-17 of High-Energy Astrophysics. Gratton, L. (ed.). New York and London, Academic Press, 1966.

A review is given for strong interaction symmetries. This review includes the properties of the elementary particles and resonances, their interactions and decay modes, SU(3) and SU(6) symmetries, and the quark model. (J.F.P.)

1470 SYMPLECTIC SYMMETRY OF STRONG INTERACTIONS. Struminskii, V. B. pp 5-21 of Problemy Teorii Gravitatsii i Elementarnykh Chastits. Stanyukovich, K. P.; Sokolik, G. A. (eds.). Moscow, Atomizdat, 1966. (In Russian).

Those states of particles which are transformed according to a six-dimensional representation of the Sp6 group are considered elementary. It is shown that the Sp6 theory leads to a number of consequences for known particles which agree with experiment, primarily explanation of $\phi-\omega$ mixing, the decay properties of the ϕ-meson and correlations of the amplitudes of the radiative decay of vector mesons. In the Sp6 theory the last-mentioned differ greatly from those of the SU(3) theory. At present only the prediction of $\omega \rightarrow \pi + \gamma$ radiative decay agrees in the two theories. New experimental data are needed to confirm or refute the Sp6 theory. (JPRS)

1471 STRONG DECAYS OF HIGHER SPIN BARYON RESONANCES IN O(4,2) THEORY. Barut, A. O.; Tripathy, K. C. (Univ. of Colorado, Boulder). Phys. Rev. Lett., 19: 1081-5 (Oct. 30, 1967).

The predictions of the relativistic O(4,2) theory were calculated for the decays of all the higher spin baryon resonances, giving results in good agreement with the experimental data. The SU(3) was included in the rest frame implying a definite symmetry breaking for the vertex functions. (auth)

Field Theories

General

Refer also to abstract 840.

1472 WEAK FIELDS AND SPACE TORSION. Ermakov, F. A. pp 106-8 of Problemy Teorii Gravitatsii i Elementarnykh Chastits. Stanyukovich, K. P.; Sokolik, G. A. (eds.). Moscow, Atomizdat, 1966. (In Russian).

A three-dimensional space of Euclidean connection with a metric Euclidean in the entire space and isotropic torsion is examined. The connection makes it possible to differentiate the field. It is shown that free static fields in a three-dimensional Euclidean space with isotropic torsion are weak. (JPRS)

1473 STABILITY PROBLEMS IN NONLINEAR FIELD THEORY. Rybakov, Yu. P. pp 68-97 of Problemy Teorii Gravitatsii i Elementarnykh Chastits. Stanyukovich, K. P.; Sokolik, G. A. (eds.). Moscow, Atomizdat, 1966. (In Russian).

A detailed survey of the main directions in nonlinear field theory (Einstein's point of view, the de Broglie and Heisenberg theories, and numerous other models) and of the methods available for investigating the stability of distributed systems are presented, and the results of an investigation of the stability of stationary states of a nonlinear scalar field are reported. It is concluded that the requirement of absolute stability of scalar models must be given up and replaced by that of weaker relative stability. (JPRS)

1474 EXACT FORMULA FOR A GENERAL RELATIVISTIC FLUID SPHERE. Kuchowicz, Br. (Univ. of Warsaw). Phys. Lett., 25A: 419-20(Sept. 25, 1967).

The well-known Schwarzschild internal solution for a general relativistic fluid sphere is generalized—for a static and spherically symmetric matter distribution. Formulas for the metric tensor, density, and pressure are derived. (auth)

Quantum Field Theory

1475 (ITF-67-16) INTEGRAL REPRESENTATIONS OF VACUUM EXPECTATION VALUES INVOLVING LOCAL COMMUTATIVITY. Gachok, V. P. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1967. 40p. Dep.

A further investigation into the integral representations of vacuum expectation values for products of field operators obtained by G. Kallen and Willhelmsson (Dan, Math. Fye. Medd., I, No9 (1959)). Integral representations are constructed in the Hilbert space generated by a Wightman functional, defined in a region of completely spatially separated four-vectors. To construct integral representations, expansions in elementary positive-definite kernels associated with a set of commuting self-adjoint operators are used. Afterward these integral representations are extended to the whole space by analytic continuation. There is an isomorphism between these extensions and the extensions of a set of operators of the field type to that of commuting self-adjoint operators. The results permit generalization of those due to Ruelle and deeper investigation of the problem of the existence of phases in statistical mechanics. (J.F.P.)

1476 (JINR-E2-3472) QUANTUM FIELD MODEL WITH UNRENORMALIZABLE INTERACTION. Volkov, M. K. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1967. 23p. Dep.

The unitary relativistic model of quantum field theory with rapidly increasing spectral function (i.e. it grows faster than any finite power of momentum) is investigated. It is shown that there exist nontrivial Lagrangians, leading to this kind of spectral function and allowing one to construct the local theory without the ultraviolet divergences on their basis. In this theory the S-matrix is unitary and not equal identically to unity. (auth)

1477 QUADRATIC INTERACTIONS IN QUANTUM FIELD THEORY. Landovitz, L. F. (Yeshiva Univ., New York). Acta Phys. Acad. Sci. Hung., 23: 253-8(1967).

The effects of a quadratic interaction term in a quantum field theory are studied. It is found that the exact and bare Hilbert spaces are orthogonal. Thus, if such terms occur in a theory, they must be treated exactly prior using the Dyson expansion to calculate the effects of residual interactions. (auth)

1478 ARBITRARY-ANGLE DOUBLE-LOGARITHMIC ASYMPTOTICS OF SCATTERING PROCESSES. Gorshkov, V. G. (Ioffe Inst. of Physics and Tech., Leningrad). Yadern. Fiz., 6: 579-86(Sept. 1967). (In Russian).

Double-logarithmic asymptotics of the amplitudes and cross sections of two-particle arbitrary-angle scattering processes in quantum electrodynamics were obtained. (auth)

1479 POSSIBLE GENERALIZATION OF QUANTUM MECHANICS IN A FEYNMAN FORMULATION. Nvankvo, K. I. pp 109-13 of Problemy Teorii Gravitatsii i Elementarnykh Chastits. Stanyukovich, K. P.; Sokolik, G. A. (eds.). Moscow, Atomizdat, 1966. (In Russian).

A possible generalization of quantum mechanics is sought by means of functional integration within the limits of Feynman formalism. It limits itself to nonrelativistic quantum mechanics and discusses the semigroup property, the evolution of mass and energy quantization, the Poincaré cycle, damping and nonlinearity, and the uncertainty principle. It is concluded that a generalization of the quantum theory must consider the distribution of mass and its evolution in time and the complex significance of energy. (JPRS)

1480 NORMAL REGULARIZATION OF TWO-POINT FUNCTIONS. Wessel, W. (Univ., Heidelberg). Z. Phys., 206: 471-82(1967). (In German).

A field belonging to a Heisenberg-type particle equation with operators derived from the elements of a commutator ring is quantized according to Fermi statistics. The resulting anticommutator is shown to be more general than the Lehmann-Källén type. It contains a density function for every mass value, that may be used to regularize, with the help of an indefinite metric, the Δ function without implications for the mass spectrum. (auth)

Gravitation and General Relativity

1481 (RT/FI-(67)18) ROTATION AND LORENTZ GROUPS IN A FINITE GEOMETRY. Beltrametti, E. G.; Blasi, A. A. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 1967. 25p. Dep.

The general features of the simpler relativity groups are investigated in the framework of a finite geometry built over a finite field. Some relevant properties of the finite fields, also called Galois fields, are noted. The analysis of the structure and representations of the rotation groups are considered, and this analysis is extended to the Lorentz and Poincaré groups. (J.F.P.)

1482 EXTENDED TRANSLATION INVARIANCE AND ASSOCIATED GAUGE FIELDS. Hayashi, Kenji; Nakano, Tadao (Kyoto Univ.). Progr. Theor. Phys. (Kyoto), 38: 491-507(Aug. 1967).

Gage fields together with nonlinear field equations to govern them are introduced by requiring that the Lagrangian should be invariant under an extended translation in space-time, i.e., a translation in which four parameters are replaced by four arbitrary coordinate-dependent functions. A prescription is given to convert a noninvariant canonical (pseudo) energy-momentum tensor into an invariant one. The symmetric part of these field equations is examined for the two cases: under linear and nonrelativistic approximation, it reduces to the classical gravitational-field equation; for static and spherically symmetric field, its solution is shown to correspond to Schwarzschild's solution. The antisymmetric part has no classical analogs, for there are no sources of skew-symmetric energy-momentum tensors in the classical experiments. A reasonable method is proposed to eliminate this redundant field. (auth)

1483 THE LORENTZ PRINCIPLE AND THE GENERAL THEORY OF RELATIVITY. V. Janossy, L.; Kiraly, P. (Central Research Inst. of Physics, Budapest). Acta Phys. Acad. Sci. Hung., 23: 291-309(1967).

The transformation is given explicitly with the help of which it is possible to obtain a straight system of reference from an arbitrary curvilinear representation. Applying the transformation to a representation in an inhomogeneous region leads to a nearly straight system of reference. Making use of the nearly straight representations the explicit form of the Lorentz transformations in inhomogeneous regions is obtained. (auth)

1484 GRAVITATIONAL SELF-FORCES AND RADIATION LOSSES OF CLASSICAL SPIN PARTICLES (FIRST APPROXIMATION). Goenner, Hubert; Gralewski, Ulrich; Westpfahl, Konradin (Albert-Ludwigs-Univ., Freiburg i. B.). Z. Phys., 207: 186-208(1967). (In German).

The solutions of Einstein's linearized field equations for a pole-dipole-like mass-distribution are regularized at the position of the arbitrarily moving source by means of Riesz' method of analytic

continuation. Self-force and self-torque resulting from the spin particle's gravitational proper field are computed Lorentz-covariantly. The self-force divides into the radiation reaction caused by light-like emission of field momentum and the exchange-force due to fluctuation of the convective field momentum. Gravimetric momentum emission is gauge invariant while the convective field momentum combines with the particle's mechanical momentum to a gauge invariant quantity. Corresponding considerations apply to the self-torque. (Gauge invariance refers to gauge transformations induced by arbitrary infinitesimal deviations from Cartesian coordinates into the Lorentz-covariant theory of gravitation.) (auth)

1485 HIGHER DIMENSIONAL SPACES AND SYMMETRIES ARISING ON GRAVITATIONAL FIELDS. Suveges, M. (Research Group for Theoretical Physics, Budapest). Acta Phys. Acad. Sci. Hung., 23: 315-16(1967).

It has been previously shown that the linear pseudo-groups defined by Levi-Civita transport are physical invariance groups in gravitational fields, supposed to be Riemannian manifolds M_n. It is shown how these symmetries give rise to higher dimensional spaces and symmetries of an ordinary M_n. The point is that the tangent space $T_x(M_n)$ at x is not simply a Euclidean space E_n in the ordinary sense, but each $T_x(M_n)$ is provided with a superstructure defined by the holonomy group $\Psi_x(M_n)$ at x. (C.E.S.)

1486 EXPERIMENTAL COMPARISON OF THE GRAVITATIONAL FORCE ON FREELY FALLING ELECTRONS AND METALLIC ELECTRONS. Witteborn, F. C.; Fairbank, W. M. (Stanford Univ., Calif.). Phys. Rev. Lett., 19: 1049-52(Oct. 30, 1967).

A free-fall technique was used to measure the net vertical component of force on electrons in a vacuum enclosed by a copper tube. This force was shown to be less than 0.09mg, where m is the inertial mass of the electron and g is 980 cm/sec^2. This supports the contention that gravity induces an electric field outside a metal surface, of magnitude and direction such that the gravitational force on electrons is cancelled. (auth)

1487 PROBLEMY TEORII GRAVITATSII I ELEMENTARNYKH CHASTITS. (Problems of the Theory of Gravitation and Elementary Particles). Stanyukovich, K. P.; Sokolik, G. A. (eds.). Moscow, Atomizdat, 1966. 280p.

The book included 25 chapters. Separate abstracts were prepared for all chapters. (J.F.P.)

For abstracts of individual chapters see: 1463, 1470, 1472, 1473, 1479, 1488-1496, and 1498-1507.

1488 UNITARY MODEL OF GRAVITATIONAL INTERACTION. Kolesnikov, S. M.; Sololik, G. A.; Stanyukovich, K. P. pp 45-60 of Problemy Teorii Gravitatsii i Elementarnykh Chastits. Stanyukovich, K. P.; Sokolik, G. A. (eds.). Moscow, Atomizdat, 1966. (In Russian).

A model of the gravitational field is proposed which permits interpreting gravity as a quadrupolar radiation of particles formed by combinations reducible to a hypothetical triplet particle describable as a unitary spinor. In that respect the ideas proposed previously in interpreting gravity as a fluctuation of heavy particles permit a modeling description which agrees formally with the theory of unitary symmetry, the SU(3) symmetry being replaced by isomorphous spatial symmetry, strong interaction by the gravitational field, weak interaction by the subgravitational and the quark by a single triplet spinor particle. (JPRS)

1489 SPINOR AND GRAVITATIONAL FIELD INTERACTION. Brezhnev, V. S.; Radynov, A. G.; Stanyukovich, K. P. pp 61-7 of Problemy Teorii Gravitatsii i Elementarnykh Chastits. Stanyukovich, K. P.; Sokolik, G. A. (eds.). Moscow, Atomizdat, 1966. (In Russian).

To establish the type of interaction of fermions with a gravitational field the Dirac equation must be generalized for the case where the space-time continuum satisfies a Riemannian geometry characterized by the interval $-ds^2 = g_{ik}dx^i dx^k$. A generally covariant formulation of the Dirac equations is proposed in which only components of the metric tensor are used. It is found that there is asymmetry of the masses of particles and antiparticles in a gravitational field, but that the asymmetry depends essentially on the selection of the coordinate system. It is concluded that in a gravitational field the concept of spin loses meaning as a quantum number and that the principle of combined inversion is not an absolute law of nature but depends on the selection of the coordinate system. (JPRS)

1490 FIVE-DIMENSIONAL WAVE MECHANICS. Dubrovskii, V. A. pp 98-105 of Problemy Teorii Gravitatsii i Elementarnykh Chastits. Stanyukovich, K. P.; Sokolik, G. A. (eds.). Moscow, Atomizdat, 1966. (In Russian).

It is demonstrated that four-dimensional and five-dimensional equations of wave mechanics give an identical description of phenomena if the potentials do not depend on the fifth coordinate and the field satisfying the five-dimensional equations depends on that coordinate periodically. It is concluded that the hypothesis of dependence of the interacting fields on the fifth coordinate can give the dynamic principle determining the distribution of masses of elementary particles. (JPRS)

1491 PROBLEM OF GRAVITATIONAL WAVES. Zakharov, V. D. pp 114-29 of Problemy Teorii Gravitatsii i Elementarnykh Chastits. Stanyukovich, K. P.; Sokolik, G. A. (eds.). Moscow, Atomizdat, 1966. (In Russian).

A new generally covariant criterion of gravitational fields is examined and the problem of invariant classification of gravitational fields satisfying that criterion is solved. New exact solutions of Einstein's equations are presented which generalize known solutions, and the new solutions are analyzed from the point of view of Petrov gravitational fields and the invariant criterion of gravitational fields. (JPRS)

1492 BEHAVIOR OF A PROBE PARTICLE IN SPACE-TIME WITH GRAVITATIONAL WAVES. Stanyukovich, K. P.; Zakharov, V. D. pp 130-4 of Problemy Teorii Gravitatsii i Elementarnykh Chastits. Stanyukovich, K. P.; Sokolik, G. A. (eds.). Moscow, Atomizdat, 1966. (In Russian).

An approximate solution is obtained for equations of the geodetic lines for the 4-vector velocity in space-time with a metric of the type that is the trajectory of a probe particle in that gravitational field is found. It is expressed by the integrals $v^0 + v^1 = \epsilon = \text{const}$, v^2 const cos 2kx and v^3 = const cos 2kx, from which it follows that the probe particle vibrates only in the plane (x^2x^3) transverse to the direction of propagation of the plane wave. (JPRS)

1493 CENTRALLY-SYMMETRIC MOTION OF INTERSTELLAR DUST IN THE GENERAL THEORY OF RELATIVITY. Kolesnikov, S. M.; Stanyukovich, K. P. pp 135-9 of Problemy Teorii Gravitatsii i Elementarnykh Chastits. Stanyukovich, K. P.; Sokolik, G. A. (eds.). Moscow, Atomizdat, 1966. (In Russian).

The motion of dust in interstellar space is examined from the point of view of a central observer with use of the independent variables R (a Lagrangian coordinate) and r (the instantaneous "radius") and with the assumption of zero pressure. The solution is obtained in an intrinsic frame of reference relative to which the velocity of matter is zero and can be determined as the proper-time derivative of the mean-square length measured along the "radius" R. (JPRS)

1494 GEODETIC LINES IN EINSTEIN-FRIEDMANN SPACES. Stanyukovich, K. P. pp 140-51 of Problemy Teorii Gravitatsii i Elementarnykh Chastits. Stanyukovich, K. P.; Sokolik, G. A. (eds.). Moscow, Atomizdat, 1966. (In Russian).

It is found that in Einstein-Friedmann spaces with central symmetry the geodetic lines lie in a plane which passes through the center. Equations are derived which in a central frame of reference describe a star without a pressure gradient, one whose radius is equal to its gravitational radius. An analogous result is obtained for a Friedmann universe when $a = a(t)$. At $\kappa = \text{const}$ the radius of the universe is equal to the gravitational only at a given moment of time. In quasi-Euclidean and hyperbolic models of Friedmann universes at $\kappa = \text{const}$ those universes are infinite. For all three models at $\kappa \sim$ a one can find a case where the radius of definite regions of homogeneous universes is equal to the gravitational and varies with the velocity of light. (JPRS)

1495 PROBLEM OF THE EVOLUTION OF A NONSTATIONARY STAR. Brezhnev, V. S. pp 152-7 of Problemy Teorii Gravitatsii i Elementarnykh Chastits. Stanyukovich, K. P.; Sokolik, G. A. (eds.). Moscow, Atomizdat, 1966. (In Russian).

In solving Einstein's equations of gravity with the limitation of assumed spherical symmetry, those equations are put in the form of four formulas. The case is studied where that equation is satisfactory with the arbitrary function F(t). Formulas are derived which completely describe the evolution in time of the star under consideration. (JPRS)

1496 MODEL OF AN INHOMOGENEOUS UNIVERSE. Brezhnev, V. S. pp 158-61 of Problemy Teorii Gravitatsii i Elementarnykh Chastits. Stanyukovich, K. P.; Sokolik, G. A. (eds.). Moscow, Atomizdat, 1966. (In Russian).

Einstein's equations of gravitation are solved for the case of an ideal liquid. At $a = 0$ the solution agrees with McVittie's solution describing the gravitational field of a material point in an expanding universe. At $a \neq 0$ the solution describes the gravitational

field of condensation of a liquid being strongly concentrated toward a center r = 0 and can model the gravitational field of an astronomical object of the type of a globular star cluster. That permits interpreting the complete solutions obtained as the gravitational field of an inhomogeneous expanding universe with central condensation. (JPRS)

1497 PERIHELION ADVANCE OF A PARTICLE (COMET) ORBIT IN A PERTURBED SCHWARZSCHILD FIELD. Aver'yanova, T. V. pp 162-82 of Problemy Teorii Gravitatsii i Elementarnykh Chastits. Stanyukovich, K. P.; Sokolik, G. A. (eds.). Moscow, Atomizdat, 1966. (In Russian).

Investigations of the equations for components of the energy tensor in the general case of a centrally symmetric gravitational field, on the assumption that the Schwarzschild field of the sun is perturbed by the gravitational field of external matter led to the conclusion that additional perihelion advance occurs only in the case of long-period comets of the solar system. During several orbits long-period comets can traverse essentially new regions of space and thus the probability of their encountering stars increases. (JPRS)

1498 SHOCK WAVES IN GRAVITATIONAL FIELDS. Stanyukovich, K. P.; Sharshekeev, O. pp 183-92 of Problemy Teorii Gravitatsii i Elementarnykh Chastits. Stanyukovich, K. P.; Sokolik, G. A. (eds.). Moscow, Atomizdat, 1966. (In Russian).

Specific peculiarities and the structure of shock waves are examined during their propagation in a gravitational field. When there is a discontinuity in a gravitational field, if even one of the tangential velocity components differs on the two sides of the discontinuity, there is a tangential discontinuity. For waves in fields with orthogonal metrics, if u_1 and $u_2 \neq 0$ the discontinuity is called a shock wave. The shock wave is said to be oblique if v and w $\neq 0$ and direct if v = w = 0. (JPRS)

1499 OBLIQUE SHOCK WAVES IN GRAVITATIONAL FIELDS. Sharshakeev, O. pp 193-7 of Problemy Teorii Gravitatsii i Elementarnykh Chastits. Stanyukovich, K. P.; Sokolik, G. A. (eds.). Moscow, Atomizdat, 1966. (In Russian).

Equations are derived which completely solve the problem of determining the parameters of flow behind the front of a shock wave if those values before the front are known. (JPRS)

1500 AN INVESTIGATION OF THE KRUSKAL–BRILL METRIC. Dzhuzumkulov, T.; Sharshekeev, O. pp 198-205 of Problemy Teorii Gravitatsii i Elementarnykh Chastits. Stanyukovich, K. P.; Sokolik, G. A. (eds.). Moscow, Atomizdat, 1966. (In Russian).

Correlations are derived for the unknowns h(r, t) and k(r, t), where r is the "coordinate" and t the "time", in Nordstrom's generalization of the Kruskal-Brill metric. (JPRS)

1501 SCHWARZSCHILD FIELD WITH A PURELY EUCLIDIAN SPATIAL METRIC. Stanyukovich, K. P.; Sharshekeev, O. pp 206-14 of Problemy Teorii Gravitatsii i Elementarnykh Chastits. Stanyukovich, K. P.; Sokolik, G. A. (eds.). Moscow, Atomizdat, 1966. (In Russian).

Correlations are derived for the unknowns A(r, t) and B(r, t), where r is the "coordinate" and t the "time", in the case of a Schwarzschild field where the purely spatial metric is Euclidean. (JPRS)

1502 STATISTICAL DESCRIPTION IN CURVED SPACE–TIME. Gordeev, A. N. pp 215-24 of Problemy Teorii Gravitatsii i Elementarnykh Chastits. Stanyukovich, K. P.; Sokolik, G. A. (eds.). Moscow, Atomizdat, 1966. (In Russian).

In statistical description of curved space-time in which a system of gravitating relativistic particles is to be considered, a specific difficulty arises which is often overlooked, that is, in calculating the probability that the world line of a particle intersects the infinitely small spatially similar "area" dS within the solid angle $d\Omega$ the fact that the intersection can take place at any point of dS is overlooked. A mathematical expression of that property of curved space is the nonintegrability of the system of differential equations defining the field $u^{\alpha}(x^{\tau})$ of parallel vectors. The problems which arise if general covariance is given up are explained. However, covariance can be preserved if the traditional field approach to statistical description is given up, and doing that obviously is more consistent. (JPRS)

1503 PROBLEM OF COORDINATE CONDITIONS IN THE THEORY OF GRAVITATION. Gordeev, A. N. pp 225-31 of Problemy Teorii Gravitatsii i Elementarnykh Chastits. Stanyukovich, K. P.; Sokolik, G. A. (eds.). Moscow, Atomizdat, 1966. (In Russian).

Einstein's theory of gravitation is constructed in a curved Riemannian space-time and, although all its physical values are depicted by tensors and their correlations are covariant in relation to the transformation of the coordinates, it still is examined in some specific coordinate system. Then the properties of the system used and of the studied objects must be separated. They are separated with a Cartesian (Gallilean) coordinate system characteristic of Euclidean space-time in the plane but not in the general case. To investigate the question of coordinates, various coordinate systems are examined in a curved Riemannian space. Conditions are obtained which assure continuity of all the coordinate lines and which in that sense are the only possible conditions. In addition, the incompatibility of those conditions in curved space means that if the coordinate lines of a given system are continuous the normals to the coordinate surfaces are not (and the reverse); the curvature is manifested in that. (JPRS)

1504 OBSERVED VALUES IN THE THEORY OF RELATIVITY. Filippov, G. M. pp 232-40 of Problemy Teorii Gravitatsii i Elementarnykh Chastits. Stanyukovich, K. P.; Sokolik, G. A. (eds.). Moscow, Atomizdat, 1966. (In Russian).

A generalization is made of observed values, also called chronometric invariants, in the general theory of relativity, on the assumption that they are recorded by an observer in a laboratory frame of reference. If the observer moves in relation to the laboratory frame he records somewhat different values. The formulas obtained permit calculating what will be measured by observers moving in a given ordinate system in an arbitrary manner. (JPRS)

1505 FRIEDMANN INTERVAL TRANSFORMATION. Stanyukovich, K. P.; Sharshekeev, O. pp 241-8 of Problemy Teorii Gravitatsii i Elementarnykh Chastits. Stanyukovich, K. P.; Sokolik, G. A. (eds.). Moscow, Atomizdat, 1966. (In Russian).

The case where the purely spatial part of the interval of homogeneous Einstein–Friedmann spaces is Euclidean is examined. Calculations are presented for determining the interval for homogeneous Einstein–Friedmann spaces in a comoving reference frame; only the corresponding (two) quadratures are taken for determination of ν and λ (or λ and ξ), so that the interval can be written in a centrally symmetric form or in a form with a "squared" purely Euclidean part. When ν and λ are known the mean-square velocity can be determined, and further calculations give the relation between w_1 and w_2. (JPRS)

1506 RELATIONS BETWEEN PHYSICAL VALUES. di Bartini, Robert Oros. pp 249-66 of Problemy Teorii Gravitatsii i Elementarnykh Chastits. Stanyukovich, K. P.; Sokolik, G. A. (eds.). Moscow, Atomizdat, 1966. (In Russian).

On the basis of a certain predicatively unbounded and, therefore, unique specimen, an analytical connection between fundamental physical constants is derived. A table of analytical and experimental values of certain physical constants is given and an experimental determination of units of the CGS system is made. The agreement of the theoretical and observed values of the constants permits assuming that all the metric properties of the total and unique specimen under consideration are identical with those of the observed universe, which is identical with a single fundamental "particle." (JPRS)

1507 EXISTENCE OF STABLE PARTICLES IN THE METAGALAXIE. Stanyukovich, K. P. pp 267-79 of Problemy Teorii Gravitatsii i Elementarnykh Chastits. Stanyukovich, K. P.; Sokolik, G. A. (eds.). Moscow, Atomizdat, 1966. (In Russian).

Calculations indicate that any arbitrary particle placed in a gravitational field is not in a basic stationary state. The concept of stationary state is contradictory to the principle of general covariant concepts in the general theory of relativity which states that gravitation is a universal interaction resulting in the change of the metrics and leading to the change of the geometry of space and any arbitrary condition in it. (C.E.S.)

1508 STUDY OF THE INTERACTION BETWEEN GRAVITATIONAL RADIATION AND MATTER. Cooperstock, Fred Isaac. Providence, Brown Univ., 1966. 58p.

Thesis.

An attempt is made to improve the understanding of the interaction between gravitational radiation and matter. It is motivated by the fact that gravitational radiation plays an important role in Einstein's theory of general relativity but it has never been detected. With a straightforward application of the equation of geodesic deviation, it is demonstrated that the relative separation of two uncoupled test particles is unchanged in the field of a plane gravitational wave if the particles have no initial relative velocity. An electromagnetic model oscillator is introduced to study the interaction between a gravity wave and elastically coupled particles. The model consists of a high-frequency electromagnetic wave

which is bounced between two perfectly conducting capacitor plates. The plates are oppositely charged and the system is in equilibrium under the opposing forces of radiation pressure and the electrostatic attraction. The Maxwell equations of electromagnetic theory, generalized to a form valid in the presence of a gravitational field, permit a determination of the response of the electromagnetic oscillator to gravitational radiation. The result is that small, sum and difference frequency fluctuations are imposed on the electromagnetic fields which compose the spring, but there is no tendency to generate oscillations of the plates which terminate the spring. The clear implication of this result is that passive systems cannot scatter or absorb gravitational waves. Following Einstein, a technique is outlined for calculating the rate at which work is done by a gravitational field on a distribution of stress-energy. This approach is used to calculate the interaction between two active quadrupole oscillators. Energy exchange between the oscillators is shown to be possible. The answer is found to be consistent with the energy conservation theorem involving the energy-momentum pseudotensor of the gravitational field. (Disser. Abstr.)

Scattering Theory

1509 (JINR-P2-3506) PRIMER AKAUZAL'NOI I UNITARNOI MATRITSY RASSEYANIYA. (An Example of Acausal and Unitary Scattering Matrix). Blokhintsev, D. I.; Vinogradov, V. M. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1967. 7p. (In Russian). Dep.

In the assumption of the coupling constant smallness an example of an acausal S-matrix is given, which is unitary, satisfies macrocausality, and its matrix elements have no peculiarities in the coordinate representation, at least in the approximation considered. (auth)

1510 (NYO-2262TA-163) PARTIAL-WAVE SCATTERING AMPLITUDE: ZEROS, SUBTRACTIONS, AND THE SIGN OF SCATTERING LENGTHS. Kang, Kyungsik (Brown Univ., Providence, R. I. Dept. of Physics). Sept. 1967. Contract AT(30-1)-2262. 22p. Dep. CFSTI.

In the discussion of the partial wave scattering amplitude only the general requirements such as analyticity, unitarity, temperedness, and normal threshold behavior are assumed. The approach used reflects the powerfulness and usefulness of Herglotz functions in dispersion theory. Not only can the zeros of the amplitude be specified but also both high- and low-energy behaviors can be judged. (J.F.P.)

1511 (TH-180) INTERPOLATION FORMULAS IN THE ANGULAR MOMENTUM PLANE. Sabatier, Pierre C. (Paris Univ., Orsay (France). Laboratoire de Physique Theorique et Hautes Energies). Feb. 1967. 49p. Dep.

When the potential is an analytic function of a rational power of r, analytical properties of the wave functions enable one to derive interpolation formulas in the angular momentum plane. In these formulas, products of the wave functions which correspond to two different potentials are expanded in terms of their values at an infinite discrete set of points on the real axis. These expansions hold uniformly in z. Properties of the expansion coefficients are investigated. They allow one to construct generating functions, and to obtain several interpolation formulas for functions of mathematical physics. Results are applied to the inverse scattering problem at fixed energy. They provide further information on an "angular momentum dispersion relation" obeyed by the Jost function. A semiclassical approximation is given for the interpolation coefficients and its meaning is investigated. Finally, an elementary derivation of the interpolation formulas is sketched and suggests a curious symbolic writing of the wave functions. (auth)

1512 CDD POLES AND THE LONG-RANGE CHARACTER OF POTENTIALS. Weiss, J. (Slovak Technical Univ., Bratislava). Czech. J. Phys., 17: 848-55(1967).

The possibility of determining the influence of CDD poles upon the long range behavior of potentials is demonstrated in nonrelativistic potential scattering. A method of the nonstandard inversion problem theory is used for the formulation of the corresponding CDD ambiguity analogy. (auth)

1513 GREEN'S FUNCTIONS FOR REGGE TRAJECTORIES. Delbourgo, R.; Rashid, M. A.; Salam, A.; Strathdee, J. (IAEA, Trieste, Italy). Phys. Lett., 25B: 475-6(Oct. 16, 1967).

A Feynman-like calculus is sketched where Regge trajectories are associated with propagators belonging to infinite-dimensional representations of SL(2,C). It is suggested that such a phenomenological scheme may prove more convergent than normal perturbation theory. (auth)

1514 SCATTERING OF HIGH-ENERGY PARTICLES AT LARGE MOMENTUM TRANSFER IN VIEW OF THE COMPLEX ANGULAR MOMENTA. Ansel'm, A. A.; Dyatlov, I. T. (Ioffe Inst. of Physics and Tech., Leningrad). Yadern. Fiz., 6: 591-602(Sept. 1967). (In Russian).

An attempt is made to determine the behavior of the elastic scattering cross section at high energy s and large momentum transfer t analyzing the contribution from the Mandelstam branch points in the complex plane of the angular momenta. The angular dependence and the energy dependence of the cross section are obtained in the region outside the diffraction cone but at $s \gg |t|$. The obtained behavior of the cross section is similar to the Orear behavior. However, the Orear parameter is found to depend on the energy logarithmically. The obtained energy dependence of the parameter is in a qualitative accordance with the experiment, and at the presently available energies the mean absolute value of the Orear parameter is found to be close to the observed one. The most interesting qualitative phenomenon predicted by the theory besides the exponential decrease of the cross section as a function of the momentum transfer is the oscillations of the cross section apparently observable on the experiment. The theoretical grounds of the obtained results are discussed in detail. (auth)

1515 IS THE POMERANCHON A FIXED POLE? Finkelstein, Jerome; Tan, Chung-I (Univ. of California, Berkeley). Contract W-7405-eng-48. Phys. Rev. Lett., 19: 1061-4(Oct. 30, 1967). (UCRL-17733).

It is shown that the Mandelstam cut mechanism, which allows the existence of fixed poles at negative values of angular momentum, is not sufficient to allow the Pomeranchon to have zero slope. It is suggested that this fact makes it unlikely that the Pomeranchon is a fixed pole. (auth)

Particle Accelerators

Refer also to abstracts 399, 1107, 1335, 1336, 1370, 1376, and 1644.

1516 (AD-646778) ONE-DIMENSIONAL ANALYSIS OF A TRAVELLING WAVE ACCELERATOR. Friedel, H. (Innsbruck Univ. (Austria). Institut fuer Theoretische Physik). Dec. 20, 1966. Contract AF61(052)-675. 14p. CFSTI.

The one-dimensional unsteady interaction of a plasma with a magnetic wave field in a travelling wave accelerator is investigated numerically by solving the MGD basic equations in ($B \ll 1$)-approximation. Finally a one-dimensional analytical model for such a travelling wave acceleration is given being in good accordance with the numerical results. (auth) (TAB)

1517 (AECL-2750) THE AECL STUDY FOR AN INTENSE NEUTRON GENERATOR. ING Status Report, July 1967. Church, T. G. (ed.) (Atomic Energy of Canada Ltd., Chalk River (Ontario)). 197p. Dep. CFSTI. CAN $4.00.

A project study for a proposed intense neutron generator is presented. The design of a high-current proton linear accelerator, a high-flux thermal neutron facility, and a meson facility is presented. Shielding, safety systems, research and technical applications, commercial isotope production, and project engineering are discussed in detail. (W.H.K.)

1518 (AWRE-O-52/67) THE LIFE OF TRITIUM TARGETS UNDER DEUTERON BOMBARDMENT IN AN ACCELERATOR. Smith, D. L. E. (Atomic Weapons Research Establishment, Aldermaston (England)). Sept. 1967. 17p. Dep. CFSTI. UK 3s. 0d.

Life tests have been conducted on titanium tritide and erbium tritide targets when bombarded with deuterium ions. The 14-MeV neutron output from these targets falls as the total integrated current on them increases. A secondary source of 2.5-MeV neutrons builds up rapidly, then remains at a steady level. (auth)

1519 (BNL-11766) PERFORMANCE REPORT ON THE AGS. Adams, R. R.; Cassel, R. L.; Distenfeld, C. H.; (and others) (Brookhaven National Lab., Upton, N. Y.). [1967]. 24p. (CONF-670930-14). Dep. CFSTI.

From 6th International Conference on High Energy Accelerators, Cambridge, Mass.

A brief description of the Brookhaven AGS, its performance, and current developments are presented. An increase in beam intensity and related radiation effects are discussed. Accelerator improvements and component modifications are described, and a proposed slow external beam system is discussed. (W.H.K.)

1520 (BNL-11789) LARGE BRIGHTNESS BEAMS UP TO 200 mA IN A 750 kV HIGH GRADIENT PREINJECTOR. Sluyters, Th. J. M.; Kovarik, V. J. (Brookhaven National Lab., Upton, N. Y.). [1966]. 22p. (CONF-670930-16). Dep. CFSTI.

From 6th International Conference on High Energy Accelerators, Cambridge, Mass.

Two types of high gradient accelerating tubes, the "enclosed" and the "open" structure, operate after a short conditioning period at 750 keV with an arcing rate lower than five arcs per hour. Beam currents up to 200 mA, 120 μs pulse length and one to five pulses per second have been obtained with a maximum total beam brightness of 1.4×10^{10} mA/cm^{2}rad^2 and a minimum of 2.0×10^9 mA/cm^{2}rad^2. The emittance improves for reduced pulse length. The density distributions are rather uniform after acceleration. The beam transport elements are adequate for 2/3 of their actual aperture. A fast beam loading compensation scheme reduces the voltage droop during the beam pulse to lower than 300 volts. (auth)

1521 (CERN-563(Vol.1)) DESIGN STUDY OF A 300 GeV PROTON SYNCHROTRON. VOL. I. CHAPTERS I-XIV. (European Organization for Nuclear Research, Geneva (Switzerland)). Nov. 19, 1964. 451p. Dep.

The proposed 300-GeV proton synchrotron will utilize alternating-gradient focusing to produce 10^{13} protons/second. The injector system will be composed of a 200-MeV linac whose output is increased to 8 GeV by a booster synchrotron. Component design, radiation protection considerations, and construction parameters are discussed in detail. (W.H.K.)

1522 (CERN-563(Vol.2)) DESIGN STUDY OF A 300 GeV PROTON SYNCHROTRON. VOL. II. FIGURES. (European Organization for Nuclear Research, Geneva (Switzerland)). Nov. 19, 1964. 97p. Dep.

The diagrams and figures discussed in CERN-563 (Vol. 1) are included. (W.H.K.)

1523 (CERN-702) ADDENDUM TO THE REPORT ON THE DESIGN STUDY OF A 300 GeV PROTON SYNCHROTRON (CERN-563). Billinge, R.; Blewett, M. H.; Hardt, W.; Hine, M. G. N.; Lapostolle, P. M.; Moehl, D.; Montague, B. W.; Schnell, W.; Zilverschoon, C. J. (European Organization for Nuclear Research, Geneva (Switzerland)). May 30, 1967. 110p. Dep.

A supplementary study to CERN-563 is presented. Additional site studies, developments in the design of the injection system, and experimental exploitation studies are discussed. Also, the cost estimates are updated. (W.H.K.)

1524 (JINR-P9-3440-2) KOLLEKTIVNOE LINEINOE USKORENIE IONOV. (Collective Linear Acceleration of Ions). Veksler, V. I.; Sarantsev, V. P.; Bonch-Osmolovskii, A. G.; (and others) (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy). 1967. 15p. (In Russian). Dep.

A possibility of building an accelerator based on a new collective principle of acceleration suggested by V. I. Veksler is theoretically considered and proved by experiment. The methods of creation of a bunch with a large number of particles, its acceleration, and supporting the stability of its size are considered. Certain conditions for the particle concentration as well as for the external electromagnetic fields, at which it is possible to obtain a bunch of an optimum size, are drawn from the calculations of the bunch stability. The experiments performed agree entirely with the calculation data. Consideration of different ways of supporting the bunch stability gives the possibility to choose the most effective and economically advantageous one, which is realized at the accelerator model. A choice of the accelerating system, for which the calculations of the effective electrical fields are made, is grounded. It is shown that these fields exceed considerably those obtained at present in the operating accelerators. (auth)

1525 (JINR-P9-3443) KOL'TSEVOI TSIKLOTRON S ZHESTKOI FOKUSIKOVKOI DLYA MNOGOZARYADNYKH IONOV. (Ring Accelerator with Strong Focusing for Multicharged Ions). Dzhelepov, V. P.; Dmitrievskii, V. P.; Zamolodchikov, B. I.; Kol'ga, V. V. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1967. 13p. (In Russian). Dep.

A possible use of a ring cyclotron with strong focusing for the acceleration of multicharged ions is considered. The ions with the mass number $A \geq 40$ can be accelerated up to 6-8 MeV/nucl. Two variants of the ring cyclotron with the maximal diameters 10m and 4.2m are calculated. The second variant is intended for acceleration of ions up to uranium ions. (auth)

1526 (JINR-P9-3448) RAZRABOTKA MAGNITNOI SISTEMY ELEKTRONNOI MODELI TSIKLOTRONA S ZHESTKOI FOKUSIROVKOI. (Designing of the Electron Model Magnetic System of a Strong Focusing Cyclotron). Vorozhtsov, S. B.; Zaplatin, N. L.; Sarkisyan, L. A. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1967. 34p. (In Russian). Dep.

The results are given of the designing of the magnetic system current coils for a strong-focusing cyclotron ($Q_{r,z} > 1$). The magnetic system is intended for the experimental investigation of the space charge influence on proton motion in the relativistic high-current cyclotrons. (auth)

1527 (LA-DC-8834) RESONANT SIDE-COUPLED CAVITY ELECTRON ACCELERATORS. Knapp, E. A.; Shlaer, W. J.; Swain, G. R.; Potter, J. M. (Los Alamos Scientific Lab., N. Mex.). Sept. 5, 1967. Contract W-7405-eng-36. 18p. (CONF-670930-9). Dep. CFSTI.

From 6th International Conference on High Energy Accelerators, Cambridge, Mass.

The performance of two $\pi/2$-mode electron linear accelerators already constructed, and progress on the construction of a 20-MeV, high-current, high-duty-factor linear accelerator are described. The $\pi/2$-mode accelerators are designed with side-coupled cavity chains to stabilize the electromagnetic field distributions. The 20-MeV high-current electron linear accelerator is being built to investigate some of the problems associated with the construction of the LAMPL. (W.H.K.)

1528 (LA-DC-8848) STABILIZATION OF THE DRIFT TUBE LINAC BY OPERATION IN THE $\pi/2$ CAVITY MODE. Swenson, D. A.; Knapp, E. A.; Potter, J. M.; Schneider, E. J. (Los Alamos Scientific Lab., N. Mex.). Aug. 31, 1967. Contract W-7405-eng-36. 17p. (CONF-670930-11). Dep. CFSTI.

From 6th International Conference on High Energy Accelerators, Cambridge, Mass.

The design and performance of a resonant coupling system for the drift tubes in a linear accelerator are discussed. The resonant coupling system converts the tank to resonant $\pi/2$-mode operation and is designed to stabilize the field against perturbations. (W.H.K.)

1529 (LA-DC-9016) PROSPECTS AND USES FOR MESON FACTORIES. Rosen, Louis (Los Alamos Scientific Lab., N. Mex.). [1967]. Contract W-7405-eng-36. 32p. (CONF-670930-10). Dep. CFSTI.

From 6th International Conference on High Energy Accelerators, Cambridge, Mass.

A comparison of some proposed meson factory accelerators is presented, and experimental research using meson factories is discussed. The LAMPF proton linear accelerator, designed to produce 1-mA average current of 800-MeV protons, is described. (W.H.K.)

1530 (NP-17078) UVELICHENIE PREDEL'NOGO IMPUL'SNOGO TOKA V LINEINOM USKORITELE ELEKTRONOV. (Increase of the Limiting Pulsed Current in a Linear Electron Accelerator). No. 308/VE-071. Vishnyakov, V. A.; Zykov, A. I.; Grishaev, I. A.; Grizhko, V. M. (Akademiya Nauk Ukrainskoi SSR, Kharkov. Fiziko-Tekhnicheskii Institut). 1967. 6p. (In Russian). Dep.

It was shown experimentally that the limiting value of the pulsed current increases in proportion to the increase in the number of sections making up accelerators composed of diaphragmatic waveguides with uniform parameters of the periodic structure. It is proposed that the sections be as short as possible or that long accelerating sections be composed of short subsections connected by means of hybrid E_{11} and H_{11} wave filters. (JPRS)

1531 (RHEL/R-151) NIMROD OPERATION AND DEVELOPMENT. Quarterly Report, April 1-June 30, 1967. Gray, D. E. (ed.) (Rutherford High Energy Lab., Chilton (England)). July 1967. 21p. Dep. CFSTI. UK 3s. 6d.

Under the heading "Operation" it is stated that the Nimrod beam was engaged on high energy physics research for 1031 hours out of a scheduled 1312 hours, during the quarter. Three experiments were completed, on K^-p, π^-p, and K^-d scattering; three other experiments were continued (study of Σ beta decay, π^-p differential cross-sections, polarisation of Σ^- produced in π^-p reactions); the setting-up of an experiment on Σ^+ decay parameters was completed; and a study of coherent scattering processes in the helium bubble chamber was commenced. Commissioning of the X1/K9 beam line for the 1.5m hydrogen chamber is in progress, and construction of the X2 extracted proton beam complex and associated beam lines continues. Radiation dosimetry associated with Nimrod is reviewed, and some problems on shielding are discussed. (UK)

1532 (UCRL-17795) SOME THOUGHTS ON STABILITY IN NONLINEAR PERIODIC FOCUSING SYSTEMS. McMillan, Edwin M. (California Univ., Berkeley. Lawrence Radiation Lab.). Sept. 5, 1967. Contract W-7405-eng-48. 11p. Dep. CFSTI.

A brief discussion is given of the long-term stability of particle motions through periodic focusing structures containing lumped

nonlinear elements. A method is presented whereby one can specify the nonlinear elements in such a way as to generate a variety of structures in which the motion has long-term stability. (auth)

1533 (UCRL-17797) BEAM LOSS AND SHIELDING EXPERIMENTS RELEVANT TO HIGH ENERGY PROTON SYNCHROTRONS. Gilbert, William S. (California Univ., Berkeley. Lawrence Radiation Lab.). Sept. 7, 1967. Contract W-7405-eng-48. 13p. (CONF-670930-12). Dep. CFSTI.

From 6th International Conference on High Energy Accelerators, Cambridge, Mass.

Beam loss distribution and shielding experiments are described in order to evaluate the radiation problems associated with the contemplated 200-GeV strong-focusing proton synchrotron. (B.G.D.)

1534 (UCRL-17798) SELECTION OF INJECTOR SYSTEMS. Peterson, J. M. (California Univ., Berkeley. Lawrence Radiation Lab.). Sept. 12, 1967. Contract W-7405-eng-48. 21p. (CONF-670930-17). Dep. CFSTI.

From 6th International Conference on High Energy Accelerators, Cambridge, Mass.

A discussion of injector systems considered for a strong-focusing 200-GeV proton synchrotron is presented. Systems discussed include a 2-BeV linac, fast booster, slow booster, slow Quart, and fast Quart-fast booster. (W.H.K.)

1535 (UCRL-17869) THE OMNITRON: A MEDIUM-ENERGY SYNCHROTRON FOR THE ACCELERATION OF LIGHT AND HEAVY IONS. Cole, F. T.; Main, R. M. (California Univ., Berkeley. Lawrence Radiation Lab.). Sept. 1967. Contract W-7405-eng-48. 27p. (CONF-670930-15). Dep. CFSTI.

From 6th International Conference on High Energy Accelerators, Cambridge, Mass.

A novel guide-magnet configuration has been devised that makes possible the acceleration of all charge-to-mass ratios from 0.04 to 1. A concentric storage ring, with the associated beam-switching equipment, allows for the extension of beam duty factor to essentially 100%. The storage ring can also be used in a bootstrap acceleration of heavy ions in which the ions are injected at low e/m, accelerated to a moderate velocity, stored while the accelerating ring returns to minimum field, stripped to maximum e/m, and reinjected for further acceleration. With a pressurized 3.0-MV Cockcroft-Walton injector, the proposed system is capable of accelerating all ions from protons to uranium—to energies up to 1.5 BeV for protons and 0.3 to 0.5 BeV/nucleon for the heavier ions. Intensities of 10^{12} to 10^{13} nucleons/sec for the lighter ions ($M \leq 128$) are anticipated. The heavy-ion charge-exchange probabilities determine the vacuum requirements of this system. To minimize these requirements and to increase beam intensity, a 60 cps cycling rate has been chosen. The vacuum requirements and the special rf resonator and beam-switching problems attendant with the high cycling rate are discussed. (auth)

1536 (YALE-2726-501) PULSED SOURCE OF HIGHLY POLARIZED ELECTRONS. Hughes, V. W.; Lubell, M. S.; Posner, M.; Raith, W. (Yale Univ., New Haven, Conn. Gibbs Lab.). Sept. 1967. Contract AT(30-1)-2726. 10p. (CONF-670930-13). Dep. CFSTI.

From 6th International Conference on High Energy Accelerators, Cambridge, Mass.

An atomic beam system for producing polarized electrons by photoionization of a polarized lithium-6 beam is presented. The system consists of a polarized atom source, an ultraviolet light source, and an ionization region. A pulsed source of polarized electrons with high intensity and high polarization, suitable for use with a high-energy accelerator, was produced with the system. (W.H.K.)

1537 (ANL-Trans-533) UNILAC: A LINEAR ACCELERATOR FOR ATOMIC IONS OF ANY MASS. (Heidelberg Univ. (West Germany). Institut fuer Angewandte Physik). Translated by Elmar K. Wilip (Argonne National Lab., Ill.), from German report. 18p. Dep. CFSTI. JCL $1.60 fs, $1.07 mf.

A brief description of the UNILAC linear accelerator for acceleration of all nuclei up to uranium is presented. Design considerations and preliminary cost estimates are included. (W.H.K.)

1538 (CERN-Trans-67-4) THE LIMITS FOR PROTON CURRENTS IN AN ACCELERATOR TUBE WITH STRONG FOCUSING. Abramyan, E. A.; Vecheslavov, V. V.; Kononov, V. I. (Akademiya Nauk SSSR, Novosibirsk. Institut Yadernoi Fiziki). Translated by E. Fischer from Russian report. 16p. Dep. CFSTI. JCL $1.60 fs, $0.80 mf.

The motion of an intense proton beam in an accelerator tube with strong-focusing quadrupole lenses has been studied. The maximum current I_{max} passing through the tube is calculated as function of the phase space volume V_n occupied by the beam. The conditions for injection into the tube necessary to realize the maximum current are calculated. The basic method used for the investigation is that of random search. The results can be used for choosing the working conditions of a tube, of the proton injector, and of the ion-optical matching system. (auth)

1539 (SLAC-Trans-74) PULSE SHORTENING IN A TWO-SECTION LINEAR ACCELERATOR. Vishnyakov, V. A.; Zykov, A. I.; Grizhko, V. M.; Grishaev, I. A. (Akademiya Nauk Ukrainskoi SSR, Kharkov. Fiziko-Tekhnicheskii Institut). Translated for Stanford Linear Accelerator Center, Calif., from report 277/VE-063. 14p. Dep. CFSTI. JCL $1.60 fs, $0.92 mf.

An investigation of shortening of the current pulse on a two-section linear electron accelerator is presented. The experimentally investigated effects of various factors on the character of the destruction of the beam are discussed. It is concluded that in designing strong-current accelerators, preference must be given to diaphragmetic waveguides with a low serial impedance in the hybrid wave. (W.H.K.)

1540 (SLAC-Trans-75) EFFECT OF AN EXTERNAL RF SOURCE ON THE STABILITY OF THE CURRENT PULSE IN A LINEAR ACCELERATOR. Vishnyakov, V. A.; Zykov, A. I.; Grishaev, I. A.; Grizhko, V. M. (Akademiya Nauk Ukrainskoi SSR, Kharkov. Fiziko-Tekhnicheskii Institut). Translated for Stanford Linear Accelerator Center, Calif., from report 306/VE-069. 7p. Dep. CFSTI. JCL $1.10 fs, $0.80 mf.

An investigation is made of the effect of an external high-frequency oscillation source on the shortening of the current pulse in a linear accelerator. It is shown that at a more than 10^{-8}W power level current pulse shortening begins with lower threshold current values. The dependence of pulse shortening on the generator frequency is investigated. (auth)

1541 (SLAC-Trans-76) INCREASING THE CURRENT PULSE LIMIT IN A LINEAR ELECTRON ACCELERATOR. Vishnyakov, V. A.; Zykov, A. I.; Grishaev, I. A.; Grizhko, V. M. (Akademiya Nauk Ukrainskoi SSR, Kharkov. Fiziko-Technicheskii Institut). Translated for Stanford Linear Accelerator Center, Calif., from report 308/VE-071. 7p. Dep. CFSTI. JCL $1.10 fs, $0.80 mf.

It is demonstrated experimentally that the increase of the number of sections of which the linear accelerator consists increases about the same number of times the limit value of the pulse current. It is intended to compose long accelerating sections of short subsections, connecting them by means of hybrid EH_{II} wave filters. (auth)

1542 (SLAC-Trans-77) QUESTIONS CONCERNING THE INCREASE OF THE LIMITING CURRENT IN MULTISECTION LINEAR ACCELERATORS. Vishnyakov, V. A.; Zykov, A. I.; Grishaev, I. A.; Makhnenko, L. A. (Akademiya Nauk Ukraniskoi SSR, Kharkov. Fiziko-Tekhnicheskii Institut). Translated for Stanford Linear Accelerator Center, Calif., from report 309/VE-072. 7p. Dep. CFSTI. JCL $1.10 fs, $0.80 mf.

A description is given of the experiment on increasing the limiting current in a multisection linear accelerator upon the replacement of the first accelerating section with a section in which the frequency of the hybrid EH_{II} wave differs from the frequency of hybrid waves excited by the beam in the remaining sections by 180 megacycles. This modification of the accelerator enables us to triple the pulse current, with which the shortening of the current pulse begins. (auth)

1543 TWO FREQUENCY MICROTRON. Rosander, S. (Royal Inst. of Tech., Stockholm). Nucl. Instrum. Methods, 56: 154-6(Nov. 1967).

A method of increasing the beam current of a microtron is described. With the aid of a second resonator large phase-stable regions can be obtained. (auth)

1544 PNEUMATIC TRANSFER SYSTEM AND SAMPLE ROTATOR FOR LINAC IRRADIATIONS. Wilkniss, P. E.; Hoover, J. I.; Leighton, R. E. (Naval Research Lab., Washington, D. C.). Nucl. Instrum. Methods, 56: 120-4(Nov. 1967).

An instrument is described which permits reproducible irradiations to be performed in the bremsstrahlung beam of a linear accelerator. (auth)

1545 AEROSOL AND DUST RADIOACTIVITY IN THE HALLS OF HIGH-ENERGY ACCELERATORS. Charalambus, St.; Rindi, A. (European Organization for Nuclear Research, Geneva). Nucl. Instrum. Methods, 56: 125-35(Nov. 1967).

In the halls of high-energy accelerators radioactive dust normally found is produced mainly by natural erosion and by wear or work of radioactive machine parts. The main radionuclides which could be present in the loose radioactivity are listed. They are

produced by spallation, fission, and capture reactions of primary and secondary particles with the machine components. From measurements made at the CERN 28 GeV/c Proton synchrotron, the main radionuclides found in dust are: ^{54}Mn, ^{7}Be, ^{51}Cr, ^{59}Fe and ^{48}V with an average relative concentration of about 50, 25, 7, and 9% respectively. The quantity and the $(MPC)_a$ of these radionuclides were taken into account and rules of general interest are finally proposed for the evaluation of the hazard from loose radioactivity near high-energy accelerators. (auth)

1546 ALTERNATING DIRECTION IMPLICIT METHOD APPLIED TO THE CALCULATION OF A MAGNETIC FIELD FROM A MEASURED BOUNDARY. Groth, T.; Olsen, B.; Pettersson, G. (Univ. of Uppsala). Nucl. Instrum. Methods, 56: 61-8(Nov. 1967).

An alternating direction implicit (ADI) method is applied to the problem of calculating the components of a magnetic field in a grid, when values of the components are given on the boundary. The calculations are here applied to the axially symmetric case of a long lens spectrometer. The procedure may be extended to a multidimensional case. The ADI method is shown to give more accurate magnetic fields compared to measured fields all over the region, both in regard to systematic and random errors in the measurement. The ADI-method thus turns out to be useful as soon as an accurate determination of a magnetic field in a region is of interest, e.g., for cyclotron calculations and investigations of different types of magnetic lenses. (auth)

1547 USE OF METAL TARGETS BOMBARDED BY ARGON IONS AS A NEGATIVE ION SOURCE. Perdrix, M.; Paletto, S.; Goutte, R.; Guillaud, C. (Institut National des Sciences Appliquees, Villeurbanne, France). Nucl. Instrum. Methods, 56: 23-31(Nov. 1967). (In French).

The nature and intensity of negative ions emitted by Be, C, Al, Cu, Mo, Ag and Au targets bombarded by A^+ ions are studied. Measurements are carried out in the residual atmosphere at a pressure of 10^{-5} Torr. The variation of the emission as a function of time, as well as the pressure influence on the ion intensity are observed and the mean energy dispersion of some of the ions emitted by Be and C samples is determined. (auth)

1548 METHOD FOR STABILIZING PARTICLE ORBITS IN THE RACE-TRACK MICROTRON. Babic, H.; Sedlacek, M. (Royal Inst. of Tech., Stockholm). Nucl. Instrum. Methods, 56: 170-2(Nov. 1967).

Axial stability and synchronism of particle motion in the race-track microtron, attained by a simple correction of the magnet fringing fields, are discussed. (auth)

1549 AUTOMATION OF RADIOTECHNICAL MEASUREMENTS IN ACCELERATORS. Rubchinskii, S. M. (Radiotechnical Inst., Moscow). Vestn. Akad. Nauk SSSR, No. 5, 43-6(May 1967). (In Russian).

Systems for the automatic radiotechnical measurements of the basic parameters of the 70-GeV synchrophasotron and radioelectric devices for the automatic measurement of the characteristics of the magnetic field of electromagnets of this accelerator were designed. The characteristics which these systems must have are briefly indicated and their development and operational characteristics are described. (J.S.R.)

1550 INVESTIGATIONS ON A FFAG ELECTRON SYNCHROTRON OF THE RADIAL SECTOR TYPE (TERMINAL ENERGY OF 150 MeV). VIII. THE MAGNETIC GUIDING FIELD. Arendt, F.; Rassow, B.; von Schaewen, J. (Freie Univ., Berlin). Nucl. Instrum. Methods, 56: 234-44(Nov. 1967). (In German).

For a FFAG-accelerator the realization, measuring, and correcting of the magnetic guiding field is described. The shape of the pole faces and the form of the pole face windings are given by the magnetic scalar potential. Three methods for calculating the equipotential surfaces are given and the influence of the azimuthal field distribution on the form of the equipotential surfaces is investigated. Model magnets scaled 1:2,5 and the measuring equipment are described. The magnetic field errors and the measuring equipment are described. The magnetic field errors and the methods for correcting the field are discussed. Based on this model experiment the parameters for an 1:1 magnet are set up. One result of the discussion of these parameters is that the magnet with vertical yokes for the return flux (Sector-magnet) has advantages compared to the magnet with horizontal yokes (Ringmagnet). (auth)

1551 CIRCULAR ORBIT OF AN ELECTRON WITH RELATIVISTIC MASS IN AN ELECTROMAGNETIC FIELD WITH AXIAL SYMMETRY AND ITS STABILITY. Vacca, Maria Teresa. Atti Accad. Sci. Torino. I. Cl. Sci. Fis., Mat. Natur., 101: 481-502(1966-67). (In Italian).

The motion of an electron of relativistic mass in an electromagnetic field with axial symmetry and a magnetic field parallel to a given axis Z was studied. The conditions for the electron to move in a circular motion in the plane Z = 0 were established. In the case of a particular electromagnetic field sinusoidal with respect to time the stability of such circular motion was discussed. This study was extended to the case in which the magnetic field has a nonzero radial component. (tr-auth)

1552 PROPERTIES OF ELECTROMAGNETICALLY SEPARATED NOBLE GAS TARGETS FOR NUCLEAR REACTION STUDIES. Selin, E.; Arnell, S. E.; Almen, O. (Chalmers Univ. of Tech., Goteborg). Nucl. Instrum. Methods, 56: 218-28(Nov. 1967).

Backing materials for electromagnetically separated noble gas targets are discussed. Ion beams of ^{22}Ne and ^{40}Ar in the energy range 2-75 keV were shot into the common backing materials tantalum and molybdenum, and the distributions of the collected noble gas atoms in saturated backings were studied by means of (p,γ)-reactions. Tables of experimental half-widths of the distributions are given in $\mu g/cm^2$. Some measurements were made in order to elucidate the collection process. (auth)

1553 DESIGN OF A HIGH-ENERGY, HIGH-DUTY CYCLE, RACETRACK MICROTRON. Wilk, B. H.; Wilson, P. B. (Stanford Univ., Calif.). Contract Nonr 225(67). Nucl. Instrum. Methods, 56: 197-208(Nov. 1967).

The design of a split-magnet racetrack microtron with a maximum final energy between 400 and 600 MeV is considered. Detailed calculations of the beam optics are presented. It is shown that adequate focusing can be provided by quadrupoles placed on the individual orbits. The phase stability of the device is investigated. The phase stable region is sufficiently large so that the tolerances on the homogeneity of the magnetic field and stability of the accelerating voltage are reasonable. As the result of phase focusing, the energy resolution of the microtron is on the order of 10^{-3}. Design parameters for a conventional (non-superconducting) rf system are given. Depending on the choice of an rf power source, the proposed microtron can provide an average current at maximum energy of 50 to 100 μA at a duty cycle of 3 to 6%. At 200 MeV the average current is 75 to 200 μA and the duty cycle is 10 to 30%. In comparison with an electron linac using a comparable amount of average rf power, the energy homogeneity and duty cycle of the microtron are superior by an order of magnitude. In addition the microtron is considerably more compact and is less expensive to build. (auth)

1554 KINEMATIC METHOD FOR DETERMINATION OF ACCELERATOR BEAM ENERGIES. Chaudhri, M. Anwar (Allgemeine Elektrizitaetsgesellschaft, Frankfurt am Main). Nucl. Instrum. Methods, 56: 338-40(Nov. 1967).

A simple and quick method for determination of accelerator beam energies is described. It is shown that a reaction or scattering spectrum from a multitarget (containing two or more nuclei of well-known excited states), taken at 90° (lab.), gives the energy calibration of the detecting system and the absolute energy of the incoming beam. Correction for relativistic energies is also given. No special apparatus is required. The method is applicable over a wide range of energies and for different sorts of particles. An alternative method using a single-target (one nucleus of well-known excited states) is discussed. (auth)

1555 IMPROVEMENTS TO THE 110 CM FIXED FREQUENCY CYCLOTRON OF THE NATIONAL PHYSICAL RESEARCH LABORATORY. Rautenbach, W. L.; de Velde Harsenhorst, Z.; Bruins, L. D.; Spoelstra, B. (CSIR, Pretoria). Tydskr. Natuurwetensk., 7: 333-51(June 1967).

The maximum intensity of the internal 16-MeV deuteron beam has been increased from 200-300 μA by improving the axial beam focusing at the center of the machine. This was achieved by: increasing the dee voltage from 55 kV to 70 kV, increasing the magnetic field in the center, using coils inside the vacuum chamber, and improvements to the ion source and extraction system. Improvements were also made to the deflecting channel, resulting in 20-30 per cent of the internal beam being deflected. Approximately 20 per cent of the deflected beam can be focused at a distance of 10 meters from the cyclotron. Highest intensity of the total external beam used so far is 80 μA with 13 μA focused in a 1 cm^2 spot by a quadrupole system. The main modifications described were completed at the end of 1962 and the cyclotron has since then been in satisfactory operation. (auth)

1556 IMPROVEMENTS IN OR RELATING TO DIFFERENTIAL PUMPING TUBES FOR ELECTROSTATIC PARTICLE ACCELERATORS. Howe, Frederick Albert; Bell, Ronald Inch (to United Kingdom Atomic Energy Authority). British Patent 1,087,725. Oct. 18, 1967. Filed Nov. 19, 1964.

The design of a differential pumping tube for an electrostatic

particle accelerator is presented. The tube contains annular electrodes which contain diametrical bars arranged to produce an electric field between adjacent electrodes having a component directed toward the tube axis. The tube is designed to combine a high degree of electron suppression with low-impedance to gas flow. (W.H.K.)

1557 METHOD AND APPARATUS FOR OPTICALLY DETERMINING THE ALIGNMENT OF MAGNETIC FIELDS UTILIZING THE COTTON–MOUTON EFFECT. Johnson, Rudin M. (to U. S. Atomic Energy Commission). U. S. Patent 3,353,097. Nov. 14, 1967.

A highly accurate means for visually locating the center of certain forms of magnetic fields, such as quadrupole lens fields, which are used for focussing charged particle beams is described. The apparatus includes a cell containing a liquid of the class which exhibits the Cotton–Mouton effect whereby plane polarized light may be passed through the liquid unchanged only along planes which are normal or parallel to a surrounding magnet field. Thus when the cell is viewed through a plane polarizing screen, in the case of a quadrupole field for example, a dark cross appears which is centered on the axis of the field. The invention may also be adapted for measuring field intensity and for locating the median plane of an accelerator magnet. (AEC)

PHYSICS (NUCLEAR)

Neutron Interactions with Matter

Refer also to abstracts 1517 and 1655.

1558 (AEEW-M-774) THE FORMAT OF BINARY TAPES OF THE U.K.A.E.A. NUCLEAR DATA LIBRARY. Doherty, G.; Norton, D. S. (Atomic Energy Establishment, Winfrith (England)). Sept. 1967. 9p. Dep. CFSTI. UK.

The Nuclear Data Library is represented primarily in a binary code decimal format on IBM cards or magnetic tape. The KDF9 computer, however, is oriented towards binary mode input and output, and the comparative slowness of the IBM compatible unit make the use of binary mode library tapes essential. The format of these tapes is described, and also a "screening package" which can be used to manipulate binary tapes at the card image level. (auth) (UK)

1559 (CTH-RF-12) DETERMINATION OF THE DIFFUSION PARAMETERS FOR THERMAL NEUTRONS IN WATER USING THE PULSED METHOD AND SPHERICAL GEOMETRIES. Elkert, Jan (Chalmers Tekniska Hogskola, Goteborg (Sweden). Institutionen for Teoretisk Fysik). June 1967. 66p. Dep. SW.

The diffusion parameters for thermal neutrons in water were determined at the temperature 21.7°C by means of the pulsed neutron source method and using spherical geometries. The values were obtained with the buckling dependence of the extrapolation distance according to the calculations by Schmidt and Gelbard. The experimental data did not permit an estimation of the parameter F. It was also found that different buckling dependence of the extrapolation distance and different weight factors in the least-squares fit affect the parameters, especially C, and make a comparison with the values of C obtained in earlier experiments somewhat doubtful. (auth) (Sweden)

1560 (EUR-3620e) THE j_N METHOD FOR NEUTRON TRANSPORT PROBLEMS IN A HOMOGENEOUS SLAB. Asaoka, T. (European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center). July 21, 1967. 47p. Dep.

The j_N method (a new analytical approach) is applied within the context of a multigroup model to solve neutron transport problems for an infinite homogeneous slab with finite thickness under the assumption that the scattering of neutrons is spherically symmetric in the laboratory system. Stationary energy-space-angle dependent problems are treated as a special case of time dependent problems. The numerical results for the vector flux generated by a stationary boundary source show that the j_5 approximation gives an accuracy comparable to the S_8 approximation in Carlson's theory, regardless of the size of the system. The numerical values of the time-eigenvalues are shown for a one-group model and those of the first eigenvalue (asymptotic decay constant) are compared with Judge and Daitch's results. Their values agree well with the results of our j_0 approximation but appear slightly too large for thick slabs when compared to the more accurate j_4 results. (auth)

1561 (KAPL-P-3391) P_L BLACKNESS THEORY IN PLANE GEOMETRY. Congdon, S. P.; Mendelson, M. R. (Knolls Atomic Power Lab., Schenectady, N. Y.). [1967]. Contract W-31-109-eng-52. 36p. (CONF-671102-28). Dep. CFSTI.

From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill.

The derivation of blackness boundary conditions is reviewed and is generalized into a standard matrix formalism that is valid for P_L approximations of any order. It is then shown that effective diffusion and absorption matrices which can reproduce blackness boundary conditions at the interfaces can be found. The effective matrices are evaluated explicitly for the case of the P_3 approximation. The results of numerical calculations for a model problem consisting of a black slab in an infinite scattering medium with a uniform source are presented. Equivalent diffusion and absorption matrices for the finite mesh point description of the black region are given explicitly for the cases of two and three mesh points. (D.C.W.)

1562 (NAA-SR-Memo-12531) OPTIC II: A SPHERICAL OPTICAL MODEL CODE. Dunford, C. L. (Atomics International, Canoga Park, Calif.). Sept. 21, 1967. 13p. Dep. CFSTI.

A spherical optical model is widely used in the analysis of scattering of light by and intermediate-weight nuclides. Several computer codes are available, each with several advantages and disadvantages when compared with another code. The OPTIC code written at Knolls Atomic Power Laboratory was chosen because it included, among other things, an R-matrix theory addition to the optical model. This code was converted from Fortran II to Fortran H, and several new features were added to compensate for known deficiencies. (auth)

1563 (NAA-SR-Memo-12532) CONVERSION AND MODIFICATION OF 2 PLUS. Dunford, C. L. (Atomics International, Canoga Park, Calif.). Sept. 19, 1967. 10p. Dep. CFSTI.

The deformed-nucleus optical model code 2 PLUS is used extensively by the Cross Section Project in the analysis of scattering cross sections for heavy even-even nuclides. With the advent of the IBM-360, Model 50, conversion from FORTRAN II to FORTRAN H was necessary. During the conversion, an attempt was made to optimize the coding and relieve some restrictions. In addition a complex coupling instead of a real coupling between the ground state and the first excited level was added. (auth)

1564 (ORNL-CDC-2) CALCULATED NEUTRON MULTIPLICATION FACTORS OF UNIFORM AQUEOUS SOLUTIONS OF ^{233}U AND ^{235}U. Webster, J. Wallace (Oak Ridge National Lab., Tenn.). Oct. 1967. Contract W-7405-eng-26. 39p. Dep. CFSTI.

Computations of the effective neutron multiplication factor of single units of aqueous solutions of $^{233}UO_2F_2$ and $^{235}UO_2F_2$ are reported for guidance in the specification of limits applicable to processes, such as storage and transport, for these fissile isotopes. Graphs are presented of k_{eff} as a function of such parameters as the mass of fissile material, the chemical concentration, the dimensions of spheres and infinitely long cylinders, and the thickness and areal density of infinite slabs. Transport theory (DTF) codes in the S_8 approximation with Hansen–Roach cross sections were utilized and the results agree with relevant experiments to within 0.01 in k_{eff}. (auth)

1565 (ORNL-CDC-4) EFFECT OF UNIT SHAPE ON THE CRITICALITY OF ARRAYS. Thomas, J. T. (Oak Ridge National Lab., Tenn.). Oct. 1967. Contract W-7405-eng-26. 19p. Dep. CFSTI.

The known criticality of uranium metal enriched to 93 wt % in ^{235}U as subcritical cylindrical components in unreflected arrays is used to explore component geometry effects in such arrays. Three basic geometries are chosen; the cube, the sphere, and the cylinder with equal height and diameter. It is shown that the multiplication factor of a unit defines sizes of the three shapes useful in establishing critical arrays equivalent to a given reference array. The number of components and the average uranium density of the equivalent arrays are the same as the reference array. The effects of changes in average unanium density and component mass on the array multiplication factor are investigated. (auth)

1566 INVESTIGATION OF HYDROGEN AND DEUTERIUM VIBRATIONS IN METAL HYDRIDES, HYDRO-DEUTERIDES, AND DEUTERIDES WITH TOTAL NEUTRON CROSS SECTIONS. Schmidt, U. (Univ., Kiel). Atomkernenergie, 12: 385-94 (Nov.-Dec. 1967). (In German).

Total cross sections for thermal neutrons were measured as a function of the neutron energy for zirconium and titanium hydrides with various hydrogen concentrations, zirconium hydro-deuterides with different hydrogen and deuterium proportions; and zirconium and titanium deuterides at room temperature. Moreover, measurements of neutron scattering in $ZrH_{1.63}$ were made in the temperature range from 25 to about 890°C. The results clearly show the effect of the inelastic scattering of neutrons, due to excitation of the hydrogen and deuterium vibrations in the metal hydride lattice. The cross sections were calculated theoretically assuming the hydrogen atoms to be bound in an isotropic harmonic potential. A comparison with the experimental cross sections is given. (auth)

1567 INFLUENCE OF CHEMICAL BINDING ON NEUTRON-CROSS-SECTIONS AT HIGHER ENERGIES. Drittler, K. (Gesellschaft fuer Kernenergieverwertung in Schiffbau und Schiffahrt mbH, Ger.). Atomkernenergie, 12: 399-403(Nov.-Dec. 1967). (In German).

Using the formalism of van Hove, a formula was derived, from which the influence of chemical binding on neutron cross sections at higher energies can be calculated. Only if strongly inharmonic and anisotropic binding forces are not present, the cross section is equal to that of free atoms. But strongly inharmonic and anisotropic binding forces are to be expected in crystals. Therefore, crystals with atoms of middle and high mass numbers should show effects of the crystal binding on the cross section up to a few keV. Since these effects are comparatively small and nearly temperature-independent, it is difficult to measure them. Using the anisotropic properties of the chemical binding in crystals, the transmission ratios of copper single crystals, for two different

crystallographic orientations, were measured from 9 to 3000 eV. Comparing these results for the two orientations, it is obvious that with great probability, there is an influence of the chemical binding. The significance of these effects for reactor calculations is briefly discussed. (auth)

1568 CRITICAL MAGNETIC SCATTERING OF NEUTRONS AND THE $|\sin \kappa_2 r|/r$ SPIN CORRELATION. Kocinski, J. (Warsaw Technical Univ.); Mrygon, B. Phys. Lett., 25A: 600-1(Oct. 23, 1967).

Experimental data on critical magnetic scattering of neutrons are explained in terms of the $|\sin \kappa_2 r|/r$ spin correlation, and the possibility of detection of the predicted diffraction minima is pointed out. (auth)

1569 CRITICAL MAGNETIC SCATTERING OF NEUTRONS IN COBALT. Bally, D.; Popovici, M.; Totia, M.; Grabcev, B.; Lungu, A. M. (Inst. for Atomic Physics, Bucharest). Phys. Lett., 25A: 595-6(Oct. 23, 1967).

Parameters characterizing the asymptotic decay of spin correlations at large distances in cobalt at temperatures above the Curie point are deduced from neutron small-angle scattering measurements. (auth)

1570 NEUTRON TECHNIQUES IN CONDENSED STATE PHYSICS. Raievski, Victor (Joint Research Center, Ispra, Italy). Euratom Bull., 6: 67-77(Sept. 1967).

The techniques for using neutrons in studies of condensed matter, i.e., of solids and liquids, are briefly reviewed. Techniques and equipment discussed are Bragg diffraction; time-of-flight; reactors, including stationary and pulsed; and very intense neutron sources. (S.F.L.)

1571 SOLUTION OF ONE-DIMENSIONAL GROUP-DIFFUSION EQUATION BY LAPLACE TRANSFORMATION. Kobayashi, Keisuke; Nishihara, Hiroshi (Kyoto Univ.). J. Nucl. Sci. Technol. (Tokyo), 4: 468-76(Sept. 1967).

A group-diffusion equation for a multiregion in one dimension is solved by applying the Laplace transformation and an analytical continuation. Applying the Laplace transformation, a group-diffusion equation is transformed into a system of linear algebraic equations. They are formulated with the use of the transfer matrix adopted in the method by Lie-series. Solutions are given in three different forms, analytical, Taylor's series, and in a form used in the source iteration method. (auth)

1572 QUALITY OF CYCLOTRON PRODUCED NEUTRONS. Schultz, J. N. (Univ. of Washington, Seattle); Glass, W. A. Health Phys., 13: 1237-9(Nov. 1967).

The studies reported concern the quality of the neutron radiation produced when a thick Be target is bombarded with 21-MeV deuterons and with 42-MeV alpha particles. Radiation quality was assessed by measuring the absorbed dose as a function of the distribution of absorbed energy in microscopic spherical absorption sites. The experimental measurements were made in the external beam target room of the University of Washington 60-in. cyclotron. The studies included the effect of depth into the absorbing medium on the quality of the neutron dose. (UK)

1573 MEAN COLLISION PROBABILITY FOR FINITE CYLINDERS AND OTHER CONVEX SOLIDS. Zharkov, V. A.; Terent'ev, V. P. At. Energ (USSR), 22: 229-30(1967). (In Russian).

The mean single-collision probability (P) of a neutron with matter, containing uniformly distributed sources must be known in order to solve certain applied neutron transport problems, such as the calculation of the resonance absorption escape probability, self-shielding coefficient, etc. Previous data allow calculation of the value of P for spheres, infinite cylinders, and flat discs. The calculations were extended to include cylinders, in which the height-to-radius ratio, α, is close to 1. The calculations show that for values of a (a function of the neutron interaction cross section) <0.1 to 0.2, the value of P first decreases with increasing α, passing through a minimum at $\alpha = 1$ to 2, tending toward the value of P_{fc} for finite cylinders. For $\alpha > 1.5$ to 2, P first increases from the P_{fc} value as α increases, then decreases toward P_{ic} for infinite cylinders. In view of the relatively small changes of P as a function of α, its value for any given cylinder and any cross section of interaction may be computed easily. If the collision probability for a finite cylinder is known, the value of P may be estimated for other convex solids using L. Dresner's theorem. (TTT)

1574 CALCULATION OF THERMAL NEUTRON ENERGY SPECTRA IN A HETEROGENOUS LATTICE. Hron, Miroslav (Inst. of Nuclear Research, Czechoslovak Academy of Sciences, Rez). Jad. Energ., 13: 217-18(June 1967).

The system of equations for the spectra of thermal neutrons in various regions of a reactor cell is derived from the integral transport equation using the principle of periodic lattice, the theory of the first flight collision probability, and dividing of the energy interval in many groups. Results for a one-dimensional uranium-graphite system are presented. (JPRS)

1575 SMALL-ENERGY-TRANSFER SCATTERING OF COLD NEUTRONS FROM LIQUID ARGON. Skold, Kurt (Aktiebolaget Atomenergi, Studsvik, Sweden). Phys. Rev. Lett., 19: 1023-5 (Oct. 30, 1967).

The quasielastic scattering of 4.1-Å neutrons from liquid argon at 94 ± 2°K was studied for wave-vector transfers in the region $1.3\ \text{Å}^{-1} < Q < 2.6\ \text{Å}^{-1}$, which covers the main peak in the liquid structure factor. The peak intensity and peak width exhibit the same type of oscillatory behavior observed earlier in other coherently scattering liquids. A simple modification of Vineyard's convolution approximation is described by which these oscillations are quantitatively explained. (auth)

1576 SPECIMEN CONTAINER FOR INELASTIC NEUTRON SCATTERING STUDIES OF LIQUIDS AT HIGH PRESSURES. Skold, K.; Karlen, L.; Sciesinski, J. (Aktiebolaget Atomenergi, Studsvik, Sweden). Nucl. Instrum. Methods, 56: 305-8(Nov. 1967).

A container for inelastic neutron scattering experiments on liquid samples at pressures up to 2000 atm is described. The container is made of 12 adjacent tubes with o.d. 0.61 cm and wall thickness 0.13 cm. The tubes, which are made of a high-strength aluminium alloy, are fitted to a common header by mechanical means. The total sample area is 10×8 cm^2 and the thickness of the sample can be varied from 0.01 cm to 0.30 cm by inserting fillers made of aluminium into the tubes. Preliminary experiments on hydrogen containing liquids show that the background of neutrons scattered from the container is tolerable. The effect of increased pressure on the quasi-elastic scattering from neopentane and water is demonstrated. (auth)

1577 INTEGRAL TRANSPORT THEORY IN ONE-DIMENSIONAL GEOMETRIES. Carlvik, Ingvar (Aktiebolaget Atomenergi, Stockholm). Nukleonik, 10: 104-19(Sept. 1967).

A method called DIT (Discrete Integral Transport) has been developed for the numerical solution of the transport equation in one-dimensional systems. The characteristic features of the method are Gaussian integration over the coordinate as described by Kobayashi and Nishihara, and a particular scheme for the calculation of matrix elements in annular and spherical geometry that has been used for collision probabilities in earlier Flurig programs. A general theory including such things as anisotropic scattering and multipole fluxes is given together with a brief description of the Flurig scheme. Annular geometry is treated in some detail, and corresponding formulas are given for spherical and plane geometry. There are many similarities between DIT and the method of collision probabilities. DIT is in many cases faster, because for a certain accuracy in the fluxes DIT often needs fewer space points than the method of collision probabilities needs regions. Several computer codes using DIT, both one-group and multigroup, have been written. Experience gained in calculations with these codes has been reported in an AE report. (auth)

1578 THE RESCUE METHOD FOR RESONANCE ESCAPE PROBABILITY CALCULATIONS IN D_2O LATTICES. Bonalumi, R. (CISE, Milan). Energ. Nucl. (Milan), 14: 561-77(Oct. 1967).

A synthetic formulation of the resonance escape probability problem in a heavy water reactor, based on a specially correlated age theory model using Monte Carlo calculations, is presented. A reasonable estimate of the high-energy flux-peaking which increases the resonance absorption with respect to a 1/E spectrum is obtained. The spatial shadowing between resonances is ignored, but the comparison with a number of experimental results appears encouraging. (S.F.L.)

1579 MULTIPLE SCATTERING CORRECTION USING A COMBINATION OF MONTE CARLO AND ANALYTICAL METHODS. Cox, S. A. (Argonne National Lab., Ill.). Nucl. Instrum. Methods, 56: 245-53(Nov. 1967).

A multiple scattering correction for neutron experiments is presented. A combination of Monte Carlo and analytical methods is used. The total fractions of neutrons, integrated over all angles, which are scattered once, twice and three or more times are calculated using Monte Carlo random walk techniques. The angular distributions of the neutrons in the various orders of scattering are calculated analytically. As a result of combining Monte Carlo and analytical methods the multiple scattering correction can be applied to much thicker scattering samples than is practicable with the purely analytical approach used by many authors and is much less time consuming than the correction procedures which use the Monte Carlo random walk methods throughout. The rather sophisticated computer facility which is required by most of the

recently proposed multiple scattering corrections is not needed for the application of the presently described method. Use of a computer is required only in obtaining a least-squares fit of the experimental angular distribution to a Legendre polynomial series. (auth)

1580 NEUTRON EMISSION GROWTH IN PLUTONIUM–BERYLLIUM SOURCES. Jordan, E. D.; Bedenbaugh, W. H.; Carew, T. E. (Catholic Univ. of America, Washington, D. C.). Nucl. Sci. Eng., 308-10(1967).

The increase in the neutron emission rate of Pu–Be sources due to the β^- decay of ^{241}Pu to ^{241}Am which then emits alpha particles that contribute to the source output was analyzed. It was found that the neutron output increases with time, reaching a maximum value in about 70 yr. It is noted that Am–Be sources can be used for constant neutron emission rates. (D.C.W.)

1581 SPATIAL DISTRIBUTIONS IN WATER OF NEUTRONS FROM A 2.85-MeV T(p,n)^{3}He SOURCE. Stookaberry, R. W.; Carroll, E. E. Jr. (Westinghouse Electric Corp., West Mifflin, Pa.). Nucl. Sci. Eng., 30: 213-21(1967).

The distributions in water of indium resonance and ^{115}In(n,n')^{115m}In neutrons from a 2.85-MeV T(p,n)^{3}He source were measured. The values of the integrated plane activities perpendicular to the proton beam direction (including the extrapolated region beyond the range of measurement in each plane) are presented. The experimental results are in agreement with Monte Carlo calculations utilizing two oxygen elastic-scattering descriptions and agree within quoted standard deviations in both cases. (auth)

1582 TRUNCATION OF THE SPHERICAL HARMONIC EXPANSION OF THE TRANSPORT EQUATION. DeBar, Roger B. (Univ. of California, Livermore). Nucl. Sci. Eng., 30: 159-65(1967). (UCRL-70348).

The most general linear truncation relation for the spherical harmonic representation of the transport equation in three dimensions is shown in any order to be a partial differential equation. This equation is uniquely determined up to two independent scalar parameters in the time-dependent case and one scalar parameter in the time-independent case. In the time-dependent situation, one of the parameters may be related to the other parameter, which is pertinent to the time-independent limit, in such a way as to give correct retardation in all orders. (auth)

1583 MULTIPLE SCATTERING IN SLOW-NEUTRON DOUBLE-DIFFERENTIAL MEASUREMENTS. Slaggie, E. L. (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Nucl. Sci. Eng., 30: 199-212(1967).

Methods of correcting double-differential slow-neutron scattering data for multiple scattering were investigated and were applied to three important experimental studies of room-temperature water. The corrections obtained are very significant, particularly for low-momentum transfer data, which in some cases require corrections of 50% or more. However, uncertainties are introduced into the correction process by sensitivity to theoretical models, which must be used to calculate the multiple scattering. The choice of the correction method and the interpretation of the corrected results in the presence of these uncertainties are considered in detail. (auth)

1584 EXPRESSION FOR THE REMAINDER IN THE SPHERICAL HARMONICS METHOD. Hendry, W. L. (Los Alamos Scientific Lab., N. Mex.). Nucl. Sci. Eng., 30: 307-8 (1967). (LA-DC-8437).

Expressions are derived for the remainder that arises in a finite Legendre-moment expansion of the solution to the one-dimensional one-velocity stationary transport equation. The result is used to study the terminating condition that is commonly used in the spherical harmonics method. (D.C.W.)

1585 PERTURBATION METHOD WHICH UTILIZES THE VARIATIONAL PRINCIPLES ASSOCIATED WITH THE NEUTRON DIFFUSION EQUATION. Turley, Richard E. (Iowa State Univ., Ames). Nucl. Sci. Eng., 30: 166-75(1967).

An operator-type perturbation method which may be used to solve perturbation problems associated with the neutron diffusion equation is presented. The method is related to the hybr.J Schrodinger–Heisenberg operator methods used in quantum mechanics. The operators are derived from the variational principles associated with the neutron diffusion equation; therefore, the method includes the advantages of the variational method. Two applications in one-dimensional, one-group diffusion theory are illustrated. The first example illustrates how a plane source of neutrons can be treated as a perturbation. The solution to this problem is exact. In the second example, the solution to a simplified time-independent problem involving fission-product poisoning is presented. The solution to this example is in open form as expected. It is found by way of comparison that this operator method gives a better result in this particular example than the more familiar method of approximating the perturbed solution by an expansion in terms of eigenfunctions of the unperturbed solution. (auth)

1586 VARIATIONAL ESTIMATE OF THE DIFFUSION COEFFICIENT IN A LATTICE WITH CAVITIES. Devooght, Jacques (Univ. Libre, Brussels). Nukleonik, 10: 119-28(Sept. 1967).

The theory of Benoist is modified by using a definition of the diffusion coefficient taking into account importance weighting. It is shown that in the one group model a quadratic weighting by the fine structure flux exists instead of a linear one, and that the macroscopic variation of importance across the reactor makes the absorption correction of Benoist disappear. The Boltzmann equation for the flux perturbed by an imposed gradient is thrown into a self-adjoint form by a method of Vladimirov. A variational expression of the diffusion coefficient is given. The expression found is closely related to Dirichlet principle, and involves only differential expressions. It is shown that diffusion theory trial functions in a non-capturing medium lead to the "electrostatic" approximation. By direct extension of a method of Carter, the variational expression found is shown to be identical to the one derived above. It is shown that the relative variation of the diffusion coefficient, obtained by the introduction of cavities, is equal to the relative variation of potential energy obtained by the introduction of a dielectric cavity in a constant electric field. Henceforth, classical expressions derived by Polya and Szegő, give an explicit value for the diffusion coefficient in the presence of large cylindrical cavities of arbitrary cross-sections. Electrical analogues are briefly discussed. (auth)

1587 COMPUTER CODE ABSTRACTS: RESQ2. Anderson, B. L. (Westinghouse Electric Corp., West Mifflin, Pa.). Nucl. Sci. Eng., 30: 312(1967).

A computer code, RESQ2, which calculates neutron resonance integrals in two-dimensional, hexagonal systems of fuel, cladding, and water with a reflecting boundary is briefly described. The code is written for the CDC-6600 using FORTRAN IV and ASCENT. (S.F.L.)

1588 AN IMPROVEMENT OF THE S_N CALCULATION METHOD FOR SLAB GEOMETRY. Wagschal, J. J. (Brookhaven National Lab., Upton, N. Y.). Nucl. Sci. Eng., 30: 305-7(1967).

An improved S_N technique was developed for calculating neutron propagation in Fe and other medium-weight materials. The calculations were performed with an isotropic source at one end of a slab having a thickness of ten mean-free-paths. Numerical results are tabulated. (S.F.L.)

1589 INTERMEDIATE RESONANCE ABSORPTION FOR MULTI-NUCLIDE SYSTEMS. Goldstein, Rubin (Brookhaven National Lab., Upton, N. Y.). Nucl. Sci. Eng., 30: 304(1967). (BNL-10882).

In treating a system of N nuclides by the intermediate resonance (IR) approximation, a set of N-coupled equations for the IR parameters representing each of the scatterers is usually obtained. A technique is presented for obtaining a single more complicated equation for one fundamental quantity, which may be more convenient, numerically or otherwise. (S.F.L.)

Nuclear Properties and Reactions, A≤ 5

Refer also to abstracts 350, 1442, 1598, 1704, 1707, 1733, and 1743.

1590 TRITON BINDING ENERGY AND NEUTRON–DEUTERON SCATTERING LENGTHS FOR POTENTIALS WITH SEPARABLE VARIABLES. Petrov, N. M.; Storozhenko, S. A.; Kharchenko, V. F. (Inst. of Physics, Kiev). Yadern. Fiz., 6: 466-72(Sept. 1967). (In Russian).

The triton binding energy and the neutron-deuteron scattering lengths are calculated for various forms of the pair potential assuming that the nucleon interactions are described in terms of a nonlocal potential with separable variables. The dependence is investigated of the binding energy and of the doublet length on the singlet effective range of the nucleon interaction as well as on the form of the two-particle potential. On introducing the tensor forces, the agreement with the experimental data is considerably improved. (auth)

1591 CROSS SECTION OF THE REACTION ^{4}He(γ,p)^{3}H. Denisov, V. P.; Kulchitskii, L. A. (Ioffe Inst. of Physics and Tech., Leningrad). Yadern. Fiz., 6: 437-9(Sept. 1967). (In Russian).

The cross section of the reaction ^{4}He(γ,p)^{3}H was determined up to the energy E_γ = 50 MeV by measuring the photoproton and pho-

totriton spectra with a counter telescope. The absolute value of the integral cross section is found to be 28.0 ± 2.0 MeV · mb. (auth)

1592 SEARCH FOR T = ½ STATES IN ^{3}He BY ELASTIC SCATTERING OF PROTONS ON DEUTERIUM. Daronian, D.; Faivre, J. C.; Garreta, D.; Goudergues, J.; Jungerman, J.; Krug, H.; Mayer, B.; Pages, A.; Papineau, A.; Testoni, J. (CEN, Saclay, France). Nucl. Phys., A104: 111-12(1967).

The previously found T = ½ levels in ^{3}He were investigated by elastic scattering of protons on deuterium. Between 6.7 to 7.5 MeV and 10.3 to 11.3 MeV, no evidence of variation of the angular distribution is found. (auth)

1593 EFFECTIVE RANGE ANALYSIS OF LOW-ENERGY $\alpha-\alpha$ SCATTERING. Kermode, M. W. (Univ. of Liverpool). Nucl. Phys., A104: 49-66(1967).

The experimental S-, D- and G-wave phase shifts for the scattering of alpha particles from the ^{4}Hc nucleus are analyzed by means of the hard-core effective range formula. It is found that an effective hard-core radius can be defined which takes approximately the same value (1.7 fm) for all three partial waves. The width of the ground state of ^{8}Be is found to be 6.14 ± 0.04 eV. This compares favorably with the experimental value of 6.8 ± 1.7 eV. The justification for the use of a hard core in the $\alpha-\alpha$ interaction is given by a suggested modification to the resonating group method. Effective range formulae for scattering by Coulomb and short-range potentials without a hard core are also derived. (auth)

1594 POLARIZATION AND ASYMMETRY IN THE ^{3}He(d,p)^{4}He REACTION. II. Defacio, B. (Texas A and M Univ., College Station); Umerjee, R. K.; Gammel, J. L. Phys. Lett., 25B: 449-50(Oct. 16, 1967).

An excellent fit is obtained for both the reaction polarization $P(\theta)$ and the left-right asymmetry $A(\theta)$ for the protons from the reaction ^{3}He(d,p)^{4}He. The possible implications of the successful channel-channel coupling potential on the reaction process are presented. (auth)

1595 LEVELS IN THE FOUR-NUCLEON SYSTEM. Badalyan, A. M.; Galpern, E. S.; Lyakhovitskii, V. N.; Pustovalov, V. V.; Simonov, Yu. A.; Surkov, E. L. (Inst. of Theoretical and Experimental Physics, Moscow). Yadern. Fiz., 6: 473-87(Sept. 1967). (In Russian).

The method of K-harmonics is applied to the problem of bound states of the four-nucleon system. Taking only the lowest harmonic for any spin-isospin state with given orbital momenta, one or a system of two equations is obtained. Nineteen such equations (one corresponds to K = 0, three to K = 1 and fifteen to K = 2) were solved numerically for the pair potentials of rectangular and exponential form and of the Yukawa form. The equation with K = 0 (S = T = l = 0) gives at once two levels: the main and excited states of helium (0$^+$). The equations with K = 1 in this approximation give no real levels but are very close to being real. It was shown that the binding energy values obtained give the upper limit for the real values, i.e., the account of higher harmonics can increase the absolute value of the binding energy. The Coulomb correction to the binding energy of ^{4}He was calculated, and the energy change due to the errors in the determination of the potential parameters was found. The n^4-state (with K = 2) is absent with a large excess in potential energy. The strong dependence of the level energy on the potential form found allows one to fix this form when solving mutually the problem of two, three, and four nucleons. (auth)

Nuclear Properties and Reactions, 6 ≤ A ≤ 19

Refer also to abstracts 1581, 1632, 1687, 1704, and 1707.

1596 (ANU-P-385) INELASTIC SCATTERING OF ^{3}He FROM ^{6}Li, ^{7}Li, ^{10}B, ^{19}F, AND ^{27}Al at 10 MeV. Coop, K. L.; Poate, J. M.; Titterton, E. W. (Australian National Univ., Canberra. Research School of Physical Sciences). [1967]. 4p. Dep.

The differential cross sections for the inelastic scattering of 10-MeV ^{3}He ions by ^{27}Al, ^{19}F, ^{6}Li, and ^{7}Li at 40° and by ^{10}B at 40, 90, and 140° were measured using semiconductor detectors in the focal planes of either a Buechner mass spectrograph or a 24-in. double-focusing spectrometer to identify the particle groups. (D.C.W.)

1597 (COO-1120-68) NUCLEAR STRUCTURE LABORATORY PROGRESS REPORT, AUGUST 1, 1966–JULY 31, 1967. (Kansas Univ., Lawrence. Nuclear Physics Lab.). Sept. 1967. Contract AT(11-1)-1120. 67p. Dep. CFSTI.

PHOSPHOROUS-31—helium-3 reactions (He-3,p) at 8 MeV, collective effects in angular distribution of protons from, (E)
CARBON-14—proton capture at 352, 527, and 634 keV, nitrogen-15 energy levels and transitions from, (E)
SILICON-30—proton capture by, phosphorous-31 energy levels and transitions from, (E)
LITHIUM-6— proton capture at 0.8 to 1.8 MeV, beryllium-7 energy levels and transitions from, (E)
ALUMINUM-27—deuteron reactions (d,α) at 2.4 to 2.6 MeV, differential cross sections for, (E)
NUCLEAR REACTIONS—angular correlation measurements using Doppler-broadened gamma transitions, (E)
NUCLEAR REACTIONS—data acquisition and control systems, use of on-line computers for, (E)
SULFUR-32—proton capture by, chlorine-33 energy levels from, (E) (S.F.L.)

1598 (COO-1265-49) ANNUAL REPORT [ON NUCLEAR PHYSICS], 1967. (Minnesota Univ., Minneapolis. John H. Williams Lab. of Nuclear Physics). Aug. 1967. Contract AT(11-1)-1265. 168p. Dep. CFSTI.

The experimental research program, dealing with elastic and inelastic scattering and with pickup and stripping reactions, is summarized together with optical-model studies. Developments in detectors, targets, scattering chambers, and electronic instrumentation are reported together with the operation and modification of the linear accelerator and the tandem Van De Graaff accelerator. (D.C.W.)

1599 (UCRL-17790) A COMPARATIVE STUDY OF (p,t) AND (p,^{3}He) REACTIONS ON LIGHT NUCLEI. Fleming, Donald George (California Univ., Berkeley. Lawrence Radiation Lab.). Aug. 1967. Contract W-7405-eng-48. 151p. Dep. CFSTI. Thesis.

The (p,t) and (p,^{3}He) reactions on ^{15}N and ^{13}C targets were investigated. Transitions to mirror final states in the mass-13 and mass-11 final nuclei were studied over 15 and 12.5 MeV of excitation, respectively. Several spin and parity assignments are made. In particular, the lowest lp-shell T = ³/₂ states in these nuclei were identified. The DWBA predictions of the angular distributions arising from these (p,t) and (p^{3}He) transitions were generally found to reproduce the experimental data well. For the ^{15}N(p,t)^{13}N and ^{15}N(p,^{3}He)^{13}C reactions, these calculations were carried out using intermediate-coupling wave functions to describe the final state; for the ^{13}C(p,t)^{11}C and ^{13}C(p,^{3}He)^{11}B reactions, pure jj configurations were assumed. In addition to giving a good account of the observed angular distributions, the DWBA calculations of relative cross sections for the (p,t) transitions were also found to be in good agreement with experiment. Comparative measurements of these (p,t) and (p,^{3}He) reactions populating mirror final states was used to test some of the assumptions made in current theories of direct two-nucleon transfer reactions. The agreement in cross section ratios of mirror (p,t) to (p,^{3}He) transitions is found to improve in every case with the inclusion of a strongly spin-dependent force in the nucleon-nucleon interaction, but overall satisfactory agreement is not obtained. The (p,t) transitions are found to be generally stronger than expected relative to their mirror (p,^{3}He) transitions, and three cases are discussed where the experimental ratios of these cross sections exceed the theoretical upper limit. Interference terms arising either through the spin-orbit interaction in the optical potential or through a core-excitation mechanism are suggested as accounting for this result. (auth)

1600 NUCLEAR CROSS SECTIONS FOR CHARGED-PARTICLE-INDUCED REACTIONS N AND O. Kim, H. J.; Milner, W. T.; McGowan, F. K. (Oak Ridge National Lab., Tenn.). Nucl. Data, Sect. A, 3: 123-285(Sept. 1967).

Nuclear cross sections for charged-particle-induced reactions of isotopes of N and O are presented in tabular and graphical form. This compilation includes experimental cross-section data available in the literature before January 1, 1965, for nuclear reactions of the type A(a,b)B at all energies, where $M_a \geq$ one nucleon mass. Nuclear reactions involving mesons in the exit channel are not included. This collection supplements a previous compilation, Los Alamos Scientific Laboratory Report LA-2014. A large amount of the cross-section data is not presented either in tabular or graphical form in order to limit the size of the present compilation. A number of annotated bibliographies are included in the appendixes to provide a brief summary of these data. (auth)

1601 CROSS SECTIONS OF THE REACTIONS ^{16}O(γ,x)^{13}N, AND ^{16}O(γ,x)^{11}C, AND YIELD OF ^{12}C(γ,ῦ UP TO 55 MeV. Kraemer, K.; Buttlar, H. v.; Goldmann, A.; Huber, B. (Technische Hochschule, Darmstadt, Ger.). Z. Phys., 207: 1-13(1967).

Yield curves of the reactions ^{16}O(γ,x)^{11}C, ^{16}O(γ,x)^{13}N, and ^{12}C(γ,t) were measured relative to ^{12}C(γ,n)^{11}C with bremsstrahlung. The

cross section $\sigma[^{16}O(\gamma,x)^{11}C]$ has a shape similar to $\sigma[^{16}O(\gamma,t)]$ and shows a broad maximum near 38 MeV. Differences between $\sigma[^{16}O(\gamma,x)^{13}N]$ and $\sigma[^{16}O(\gamma,t)]$ point to a reaction mechanism via quadrupole absorption in ^{16}O. The yield of $^{12}C(\gamma,t)$ exceeds the $^{16}O(\gamma,t)$ yield by a factor of two. (auth)

1602 HEAVY-PARTICLE EMISSION FROM THE REACTIONS $^{19}F + d$ AND $^{19}F + {}^3He$. Dehnhard, D.; Gemmell, D. S.; Vager, Z. (Argonne National Lab., Ill.). Nucl. Phys., A104: 202-12(1967).

The reactions $^{19}F(d,^6Li)^{15}N$, $^{19}F(d,^9Be)^{12}C$, and $^{19}F(^3He,^{10}B)^{12}C$ were studied at bombarding energies between 7.5 and 13.0 MeV. The heavy particles emitted were identified by a simultaneous analysis of particle energy and time of flight. Differential cross sections for the reaction $^{19}F(d,^6Li)^{15}N$ were measured at several bombarding energies in the range 9.0 to 12.5 MeV. Excitation functions for this reaction were measured at $\theta_{lab} = 70°$ and 180° between $E_d = 7.5$ and 13.0 MeV. Angular distributions were measured for the $^{19}F(d,^9Be)^{12}C$ reaction at $E_d = 9.0$ and 12.0 MeV, and a 180° yield curve was measured between $E_d = 9.0$ and 12.6 MeV. An angular distribution for the $^{19}F(^3He,^{10}B)^{12}C$ reaction was obtained at $E(^3He) = 13$ MeV. The observations that in all cases the angular distributions show diffraction-like structure and the excitation functions do not fluctuate strongly indicate that a direct-reaction meachanism is dominant. However, attempts to fit the data with calculations based on the distorted-wave Born approximation and assuming pick-up of an α-particle (for the $(d,^6Li)$ case) or a ^7Li(for the $(d,^9Be)$ and $(^3He,^{10}B)$ cases) were mostly unsuccessful. (auth)

1603 PHOTOPRODUCTION OF CHARGED PIONS FROM ^{11}B. Devanathan, V. (Univ. of Virginia, Charlottesville); Rao, K. Srinivasa; Sridhar, R. Phys. Lett., 25B: 456-8(Oct. 16, 1967). (ORO-2915-84).

Numerical results for the reactions $^{11}B(\gamma,\pi^+)^{11}Be$ and $^{11}B(\gamma,\pi^-)^{11}C$ are reported and are compared with the available experimental results. The independent-particle model for the nucleus and volume and surface production mechanisms are used in the study. (auth)

1604 STUDY OF THE FIRST EXCITED STATE OF ^{12}C BY INELASTIC ELECTRON SCATTERING. Bernheim, M.; Stovall, T.; Vinciguerra, D. (Ecole Normale Superieure, Orsay, France). Phys. Lett., 25B: 461-3(Oct. 16, 1967).

An accurate measurement of the transverse and longitudinal scattering form factors from the first excited state of ^{12}C was performed at $q = 1.007$ fm^{-1}. A verification of the Born approximation was obtained from the results. (auth)

1605 ANALYZING POWER OF ^{12}C FOR VECTOR POLARIZED DEUTERONS FROM 6 TO 10 MeV. Clausnitzer, G.; Fleischmann, R.; Wilsch, H. (Univ., Erlangen-Nuremberg). Phys. Lett., 25B: 466-7(Oct. 16, 1967).

Purely vector-polarized deuterons were elastically scattered by ^{12}C in the energy region from 6 to 10 MeV. The measured asymmetries at $\theta_{lab} = 45°$ are given, and the analyzing power is evaluated. (auth)

1606 SHELL MODEL CALCULATIONS FOR ^{18}O NUCLEI WITH VELOCITY-DEPENDENT TWO-PARTICLE POTENTIALS. Grote, Hans (Univ., Goettingen, Ger.). Z. Naturforsch., 22a: 415-21(Apr. 1967). (In German).

The energies of the low-lying levels and the absolute position of the ground state of the nucleus ^{18}O are calculated using five velocity-dependent potentials. The calculation is based on the shell model with two outer neutrons in the potential of the ^{16}O core. The interaction potential as well as the core potential are fitted to experimental data, leaving no free parameters in the final result. The wave functions of the harmonic oscillator are used in each case of the five velocity-dependent potentials. An additional computation is carried out using one of these potentials and taking into account the perturbation of the wave functions. It turns out that, for satisfactory application of the velocity-dependent potentials in shell-model calculations, this perturbation should be considered. (auth)

1607 EXPERIMENTAL INVESTIGATIONS OF THE FLUCTUATION OF CROSS SECTIONS FOR THE REACTIONS $^{19}F(n,2n)^{18}F$, $^{27}Al(n,\alpha)^{24}Na$, AND $^{65}Cu(n,2n)^{64}Cu$. Bormann, M.; Riehle, I. (Univ., Hamburg). Z. Phys., 207: 64-72(1967). (In German).

Using the activation method investigations on the fluctuation of the total reaction cross sections for the reactions $^{19}F(n,2n)^{18}F$, $^{27}Al(n,\alpha)^{24}Na$, and $^{65}Cu(n,2n)^{64}Cu$ were performed in the 14-MeV region under similar conditions as in the experiments reported by Strohal et al., and by Csikai on the same subject. In disagreement to the results of these authors no considerable fluctuation amplitudes were found. (auth)

1608 CALCULATION OF EXCITED STATES FOR THE NUCLEI WITH THE MASS NUMBER A = 18 USING THE REAL NUCLEON-NUCLEON INTERACTION. Vashakidze, I. Sh. (Tbilisi State Univ., USSR). Yadern. Fiz., 6: 462-5(Sept. 1967). (In Russian).

Low-lying excited levels of nuclei with A = 18 are investigated by means of the Hartree–Fock method. The nucleon-nucleon interaction is represented by the interaction of the free nucleons in form of a nonlocal factorizable potential and the Hamada–Johnston potential. The theoretical results are compared with the experimental data. (auth)

1609 THE $^6Li(^3He,n)^8B$ REACTION MECHANISM. van der Merwe, P.; McMurray, W. R.; Van Heerden, I. J. (Southern Universities Nuclear Inst., Faure, South Africa). Nucl. Phys., A103: 474-80(1967).

The $^6Li(^3He, n_0)^8B$ reaction was studied in the bombarding energy range 4.0 to 5.7 MeV. The absence of structure in the excitation curve and the gradual variation of the forward peaked angular distribution suggest a dominant direct reaction mechanism in this energy range. The angular distributions indicate that there is a considerable contribution from the forward knock-out mode to the direct process. The results are discussed in relation to the cluster structures of ^6Li and ^8B. (auth)

1610 PHOTODISINTEGRATION OF THE ^{16}O NUCLEUS. Kabachnik, N. M.; Korotkih, V. L.; Unger, H.-J. (Moscow State Univ.). Nucl. Phys., A103: 450-60(1967).

The (γ,p) and (γ,n) reaction cross sections for the ^{16}O nucleus were calculated. The calculation was carried out with inclusion of the configuration mixing in the continuum using the method proposed by Balashov et al. Wave functions of a Woods–Saxon potential are used as the one-particle wave functions. The inclusion of the channel coupling results in the appearance of a number of resonances in the cross section with widths of 0.1 to 3 MeV. In general, the results obtained are close to the results of the traditional "particle-hole" approach omitting the specific character of the continuous spectrum. The results are compared with the experimental data. The $^{15}N(p,n)^{15}O$ reaction cross section was also calculated to check the main approximation of the theory. (auth)

1611 ELASTIC ELECTRON SCATTERING FROM ^{12}C. Crannell, Hall; Suelzle, L. R.; Uhrhane, F. J.; Yearian, M. R. (Sanford Univ., Calif.). Nucl. Phys., A103: 677-80(1967).

Using a target material consisting of methane enriched to 58% in ^{12}C, elastic electron scattering of 250 MeV energy incident electrons at a variety of angles was studied. The absolute target density was determined by electron scattering from the nuclei of hydrogen contained in the methane, and by comparing the measured cross sections with known proton cross sections. The contribution to the elastic scattering due to the ^{12}C in the target material was subtracted by a calculation which uses previously measured ^{12}C cross sections. The data are analyzed using a harmonic oscillator model. The ratio of the rms radius of the charge distribution for ^{13}C to that of ^{12}C is found to be 0.96 ± 0.01. (auth)

1612 COPLANAR AND NON-COPLANAR (p,2p) REACTIONS WITH ^{12}C. Yuasa, T.; Hourany, E. (Institut de Physique Nucleaire, Orsay, France). Nucl. Phys., A103: 577-91(1967). (In French).

The experimental results obtained with a propane bubble chamber concerning the coplanar and non-coplanar (p,2p) reaction in ^{12}C are summarized. The nuclear diffraction effect was observed. The theoretical interpretation of the recoil momentum distribution is discussed. (auth)

Nuclear Properties and Reactions, $20 \leq A \leq 89$

Refer also to abstracts 1354, 1596–1598, 1607, 1664, 1687, 1702, 1707, and 1734.

1613 (AD-646702) SHELL MODEL CALCULATION IN THE CALCIUM-ISOTOPES. Engeland, T.; Osnes, E. (Michigan Univ., Ann Arbor, Dept. of Physics). 1966. Contract Nonr-1224(59). 33p. CFSTI.

Shell-model calculations are performed for the calcium isotopes assuming an effective interaction in the $(1f_{\frac{7}{2}})^N$ and $(1f_{\frac{7}{2}})^{N-1}\,2p_{\frac{3}{2}}$ configurations. Both binding energies and level schemes are calculated in a least squares fit approach. Good agreement is obtained, particularly in the odd isotopes. The calculation is reproduced with the surface delta interaction with one unknown parameter. The results show that this force is not able to describe the energy spectra and relative binding energies. (auth) (TAB)

1614 (ANU-P-386) GAMMA RADIATION FROM THE REACTIONS $^{20}Ne(\alpha,\alpha'\gamma_{1.63})^{20}Ne$ AND $^{20}Ne(\alpha,p\gamma_{0.44})^{23}Na$. Spear, R. H.; Wright, I. F. (Australian National Univ., Canberra. Research School of Physical Sciences). [1965]. 25p. Dep.

Excitation functions for gamma radiation from the reactions $^{20}Ne(\alpha,\alpha'\gamma_{1.63})^{20}Ne$ and $^{20}Ne(\alpha,p\gamma_{0.44})^{23}Na$ were studied for bombarding energies from 3.96 to 6.08 MeV using NaI (Tl) detectors and a target of ^{20}Ne embedded in tantalum. Approximately 30 resonances were observed; some of them may be satisfactorily correlated with energy levels of ^{24}Mg reported from other reactions. Angular distribution measurements provide spin and parity assignments of 2^+ for ^{24}Mg levels at excitation energies of 12.744 and 12.810 MeV, and 4^+ or 5^- (possibly 6^+) for a level at 12.977 MeV. (auth)

1615 (ORNL-tr-1796) THE BRANCHING RATIO OF ^{87}Y. Nassiff, S. J.; Diodati, P.; de Torriani, I. L. (Comision Nacional de Energia Atomica, Buenos Aires (Argentina)). Translated by J. J. Pinajian and Martha Gerrard (Oak Ridge National Lab., Tenn.), from Spanish report No. 121. 7p. Dep. CFSTI. JCL $1.10 fs, $0.80 mf.

The relation between the transitions of the 80-hour ground state of ^{87}Y which lead to the 0.871- and 0.388-MeV levels were determined. (auth)

1616 14.8-MeV NEUTRON ACTIVATION CROSS SECTIONS FOR CHROMIUM. Husain, L.; Kuroda, P. K. (Univ. of Arkansas, Fayetteville). J. Inorg. Nucl. Chem., 29: 2665-9(Nov. 1967).

Neutron activation cross sections of chromium were measured using gamma spectroscopy and radiochemical techniques. The cross sections measured are $^{52}Cr(n,p)^{52}V$, 115 ± 15 mbarn; $^{53}Cr(n,p)^{53}V$, 44 ± 5 mbarn; $^{53}Cr(n,np)^{52}V$, 7.1 ± 1.5 mbarn; $^{54}Cr(n,p)^{54}V$, 13.5 ± 1.5 mbarn; and $^{54}Cr(n,\alpha)^{51}Ti$, 12.5 ± 1.3 mbarn. The data are in reasonable agreement with the theoretically calculated values of Gardner. (auth) (UK)

1617 THE (e,e'p) REACTION IN THE ^{75}As NUCLEUS. Amaldi, Ugo Jr.; Venuti, Gloria Campos; Cortellessa, Giorgio; De Sanctis, Enzo; Frullani, Salvatore; Lombard, Roselyne; Salvadori, Paolo (Istituto Superiore di Sanita, Rome). Atti Accad. Naz. Lincei, Rend. Cl. Sci. Fis., Mat. Natur., 41: 494-6(Dec. 1966).

The quasielastic scattering of electrons by ^{75}As at incident electron energies of 590 to 880 MeV was investigated using an experimental apparatus that was previously used for measurements on ^{40}Ca and ^{32}S. Spectra were measured in terms of counting rate vs incident electron energy and missing energy. Two peaks centered around missing energies of ~30 and 110 MeV were observed. The data were fitted with the sum of three Maxwellian curves plus a "background" straight line. It was noted that different apparatus is required for investigation of the structure of heavier nuclei by quasielastic scattering. (D.C.W.)

1618 RADIOACTIVE DECAY OF ^{61}Fe. Ehrlich, Dietrich (Univ., Goettingen, Ger.). Z. Phys., 207: 268-80(1967). (In German).

$^{61}Fe(T_{\frac{1}{2}} = 5.95$ min) was produced by irradiating ^{64}Ni and natural Ni foils with fast neutrons in the reaction $^{64}Ni(n,\alpha)^{61}Fe$. Fe was chemically separated. The gamma and beta spectrums were investigated with Ge(Li)-counters, NaI(Tl) and plastic scintillation spectrometers. ^{61}Fe emits five gamma rays having the energies and intensities per ^{61}Fe decay: 121 keV (0.064), 177 keV (0.027), 298 keV (0.293), 1025 keV (0.461), 1202 keV (0.539). Three $\gamma\gamma$-cascades could be identified: 121–177 keV, 121–1202 keV, 298–1025 keV. In $\gamma\beta$-coincidence measurements the maximal beta energy was determined: $E_{\beta max}$ = 2.86 MeV. A decay scheme $^{61}Fe \rightarrow {}^{61}Co$ was constructed: ^{61}Fe, spin and parity $J^\pi = \frac{3}{2}^-$, decays by means of allowed beta decay to three excited states of ^{61}Co: 1323 keV ($\frac{1}{2}^-$), 1202 keV ($\frac{3}{2}^-$), 1025 keV ($\frac{5}{2}^-$). The energies and intensities per ^{61}Fe decay of the three beta decay modes are: 2.56 MeV (0.367), 2.68 MeV (0.495), and 2.86 MeV (0.138). An 88 keV gamma ray ($T_{\frac{1}{2}}$ = 33 sec) was observed coming from the ^{61}Co decay. (auth)

1619 ELECTRON–NUCLEAR DOUBLE RESONANCE OF $^{55}Mn^{2+}$ IN MgO. Eskes, Y. H.; de Wijn, H. W. (Univ. of Amsterdam). Phys Lett., 25A: 553-4(Oct. 9, 1967).

ENDOR techniques were used to determine the cubic crystalline field splitting α, and the nuclear spin Hamiltonian parameters A, $g_I\mu_N$, and U of $^{55}Mn^{2+}$ in MgO at 4.2°K. The nuclear magnetic moment of ^{55}Mn was determined to be +3.437 ± 0.005 μ_N. (auth)

1620 γ RAY SPECTRUM FROM THE REACTION $^{57}Fe(n,\gamma)^{58}Fe$. Murzin, A. V.; Belykh, G. V.; Golyshkin, V. I.; Ogorodnik, A. F. Yadern. Fiz., 6: 446-53(Sept. 1967). (In Russian).

By means of three-crystal scintillation pair spectrometer placed in the output of horizontal channel of the experimental water reactor of the Physical Institute of the Academy of Sciences of the Ukranian SSR, the spectrum of γ rays appearing in the capture of thermal neutrons by the ^{57}Fe nucleus was measured. The resolution of the spectrometer is 4 to 5%. γ ray energies and intensities are given. The scheme of γ transitions for the ^{58}Fe nucleus is given taking into account the data on (d,p) and (p,p') reactions. (auth)

1621 NEUTRON SCATTERING FROM NATURAL SILICON. Knitter, H.-H.; Coppola, M. (EURATOM, Geel, Belg.). Z. Phys., 207: 56-63(1967).

Differential cross sections for elastic and inelastic scattering of neutrons from natural silicon were measured in the energy region between 4.00 and 5.75 MeV, in steps of about 250 keV in the primary neutron energy. The results are presented in form of coefficients of Legendre polynomial expansions. (auth)

1622 CROSS SECTIONS AND ISOMERIC RATIOS FOR THE REACTIONS $^{89}Y(\alpha,3n)^{90g}Nb$ AND $^{89}Y(\alpha,3n)^{90m}Nb$. Smend, F.; Weirauch, W.; Schmidt-Ott, W.-D.; Flammersfeld, A. (Univ., Goettingen, Ger.). Z. Phys., 207: 28-34(1967). (In German).

Absolute cross sections and isomeric cross section ratios were measured for the reactions $^{89}Y(\alpha,3n)^{90g,90m}Nb$. The energy of the α particles was varied between 34 and 54 MeV. The experimental isomeric ratios are compared with statistical-model calculations. (auth)

1623 THE DECAY $^{58m}Co \rightarrow {}^{58g}Co$. Strutz, Hans-Juergen. (Univ., Goettingen, Ger.). Z. Phys., 207: 119-31(1967). (In German).

^{58m}Co, ^{58g}Co, and ^{55}Co were obtained by radiating nickel foils with deuterons of energies 11.5 MeV and 2.07 MeV. The γ-radiation was measured with NaI scintillation spectrometers. For the isomeric transition of ^{58m}Co $T_{\frac{1}{2}}$ = (9.15 ± 0.1) h, E_γ = (25 ± 1) keV, α_K = 2200 ± 300, and α_{L+M} = 1100 ± 300. From these values it follows that the radiation is of M3-type. Two γ-energies of 95 keV and 1322 keV were found belonging to ^{58}Co. (auth)

1624 SYSTEMATICS OF SOME NUCLEAR PROPERTIES OF THE ODD-MASS NUCLEI IN THE REGION NEAR THE MASS NUMBER 190. Meligy, Z. (Ein Shams Univ., Cairo); Eissa, N. A. Acta Phys. Acad. Sci. Hung., 23: 277-85(1967).

The systematics of the shell and unified nuclear models were investigated for the nuclei of Lu, Ta, Re, Ir, and Au, which represent the transition region from the spherical nuclei. It was apparent from the comparison of the experimental and theoretical ratios of the first and second excited collective levels, from the quadrupole and magnetic moments that the unified model is the most coherent model in this range too, as results from the present analysis. For the ^{195}Au nucleus, it is possible to assign the spin $\frac{5}{2}^+$ and $\frac{1}{2}^+$ for the levels at 251 and 515 keV from comparison with other nuclei. The moment of inertia derived from the experimental results and from the hydrodynamic approximation for the abovementioned nuclei was compared with Migdal curves for the moment of inertia based on the superfluid model. The results confirm the superfluid description of nuclear matter. (auth)

1625 ON THE NATURE OF THE HIGH EXCITED STATES OF ^{59}Cu. Guzhovskii, B. Ya.; Borkin, I. M.; Zvenigorodskii, A. G.; Rudnev, V. S.; Solodovnikov, A. P.; Trusillo, S. V. Yadern. Fiz., 6: 433-6(Sept. 1967). (In Russian).

By studying proton elastic and inelastic scattering on ^{58}Ni at E_p = 3 to 6 MeV, about 100 resonances were found with l_p = 0 and 2, which were interpreted as the states of ^{59}Cu with T = $\frac{1}{2}$. The observation of the analog resonances is impeded by the high density and the strength of the background resonances with T = $\frac{1}{2}$. (auth)

1626 STUDY OF NEUTRON RESONANCES OF VANADIUM AND MANGANESE. Rohr, G.; Friedland, E. (Kernforschungszentrum, Karlsruhe, Ger.). Nucl. Phys., A104: 1-16(1967).

Total neutron cross sections up to about 200 keV were measured for ^{51}V and ^{55}Mn. A multi-level formula was employed to compute the resonance parameters. Spins were assigned to 21 levels in ^{51}V and 42 in ^{55}Mn. The distribution of level width obeys a Porter-Thomas distribution only in the case of ^{55}Mn; possible reasons for the deviations observed in ^{51}V are proposed. The most probable strength functions were computed as $(8.2^{+3.9}_{-2.9}) \times 10^{-4}$ for ^{51}V and $(3.1^{+0.9}_{-0.7}) \times 10^{-4}$ for ^{55}Mn. For both nuclei no spin dependence of the strength function is found; unfortunately the statistical uncertainty of the strength functions for different spin values cannot exclude a (2J + 1) dependence. In the case of ^{51}V it can be shown that intermediate structure effects may influence very strongly the result for the spin dependence of the strength function in different energy intervals. For ^{55}Mn, a spin cut-off parameter of $2.5^{+0.5}_{-0.3}$ from the resonance parameters was deduced. (auth)

1627 $^{58}Ni(p,p'\gamma)^{58}Ni$ ANGULAR CORRELATION MEASUREMENTS. Horoshko, R. N.; Hinrichsen, P. F.; Swenson, L. W.;

Van Patter, D. M. (Franklin Inst., Swarthmore, Pa.). Nucl. Phys., A104: 113-35(1967).

Angular correlation measurements in a 180° geometry for the $^{58}Ni(p,p'\gamma)$ reaction were used to determine the spins and γ-ray decay properties of states at 2.46, 2.78, 3.04, and 3.26 MeV. The 2.46 MeV state was verified to be spin J = 4, and the states at 2.78, 3.04, and 3.26 MeV were assigned spin J = 2. The (L + 1)/L mixing ratio for the 2.78 → 1.46 MeV transition is $\delta = 1.5^{+\frac{1}{.4}}_{-.3}$, strongly suggesting positive parity for this state. Using the available information for the ground state branching of this 2^+_1 state, the crossover to cascade ratio of the E2 transition rates is in disagreement by a factor of $\approx 10^4$ with the recent shell-model predictions of Cohen et al. For the 3.04 and the 3.26 MeV levels the mixing ratios δ for transitions to the 2^+_1 state are -0.1 ± 0.15 and -0.4 ± 0.2 with the corresponding branchings to the ground state of 38 ± 2% and 64 ± 2%, respectively. (auth)

1628 TEST OF THE DWBA IN (^{3}He,α) REACTIONS LEADING TO CONFIGURATION AND ANALOGUE STATES. Stock, R. (Max Planck Institut fuer Kernphysik, Heidelberg. Univ. of Copenhagen); Brock, R.; David, P.; Duhm, H. H.; Tamura, T. Nucl. Phys., A104: 136-76(1967).

The DWBA methods are re-examined to analyze the reactions $^{50,52,54}Cr(^3He,\alpha)$ at $E_{^3He}$ = 18 MeV. The use of the (^{3}He,α) reaction as a spectroscopic tool is limited by the angular momentum mismatch which causes the nuclear interior to contribute significantly to the reaction. As a consequence, some of the usual approximations become critical. The "measured" elastic scattering parameters do not sufficiently determine the cross sections. In addition, the degenerate sets of parameters for composite particle scattering in both channels cannot be combined arbitrarily. However, the exact matrix element of the distorted wave theory indicates that the α potential should be roughly equal to the sum of the ^{3}He and neutron potentials. This prescription was found to be valid by calculations of mismatch transitions using all the possible combinations of measured parameters in both channels. The effects of nonlocality and finite range are discussed. It is shown that a sharp radial cutoff is not permissible. The effects of spin-orbit coupling on the angular distributions and absolute cross sections are investigated; the J-effects of the data are partially overestimated by the calculations. The absolute normalization factor of the DWBA cross section, derived from the present analysis, agrees with theoretical predictions. The accuracy of the extracted spectroscopic factors is discussed. The bound state wave functions for the analogue state transitions are obtained by solving the coupled Lane equations. This leads to agreement of the derived spectroscopic factors with the sum rule predictions. (auth)

1629 THE DECAY OF ^{147}Nd. Canty, M. J.; Connor, R. D. (Univ. of Manitoba, Winnipeg, Can.). Nucl. Phys., A104: 35-48 (1967).

A study of the γ-ray spectrum emitted in the decay of ^{147}Nd using Ge(Li) detectors revealed the following energies (keV) and absolute photon intensities (%): 91.0(27.6), 120.6(0.33), 196.6(0.17), 275.1 (0.85), 319.3(1.86), 397.8(0.84), 409.6(0.17), 439.4(1.20), 488.5 (0.20), 530.7(13.1), 594.4(0.29) and 686.1(0.86). The levels in ^{147}Pm have energies (keV) spins and parities as follows: 0($\frac{7}{2}^+$), 91($\frac{5}{2}^+$), 410($\frac{5}{2}^+$), 488($\frac{7}{2}^+$), 531($\frac{5}{2}^+$) and 686($\frac{5}{2}^+$). It is shown that other γ-rays and levels reported in the literature belong to impurities. The β-feeds to those levels have the following end-point energies (keV), intensity (%) and $\log_{10}f_0t$ values, respectively: unobserved, 804(81.3)7.4, 485(0.6)9.1, 407(0.8)8.4, 365(15.0)7.1, 209(2.3)7.1. The shape of the first-forbidden, non-unique β-transition of end-point energy 803.5 ± 1 keV has a shape factor given by C(W) = k(1 + aW) with the value of a given by −0.125 ± 0.02. The Q_β value is 894.5 keV. (auth)

1630 EXCITATION OF THE 0,908 MeV LEVEL IN ^{89}Y BY INELASTIC SCATTERING OF 61.2-MeV PROTONS. Scott, A. (Univ. of Georgia, Athens); Whiten, M. L.; Ball, J. B. Phys. Lett., 25B: 463-5(Oct. 16, 1967).

The differential cross section for the excitation of the 0.908-MeV level in ^{89}Y by 61.2-MeV protons was measured over the angular range from 17 to 120°. The results are compared with calculations using the microscopic description of the inelastic scattering process. (auth)

1631 $1f_{\frac{5}{2}}$ AND $2p_{\frac{1}{2}}$ STATES IN ODD-A NUCLEI FROM ^{33}S TO ^{41}Ca. Watson, D. D.; Lee, F. D. (Aerospace Research Labs., Wright-Patterson AFB, Ohio). Phys. Lett., 25B: 472-4(Oct. 16, 1967).

A number of energy levels of d-shell nuclei exhibit prominent single-particle $1f_{\frac{5}{2}}$ or $2p_{\frac{1}{2}}$ characteristics. A single-particle description is used to fit the known energy levels, and from this fit the energies of other possible $1f_{\frac{7}{2}}$ and $2p_{\frac{3}{2}}$ states are predicted. (auth)

1632 INVESTIGATION OF THE MECHANISM OF (p,n) REACTIONS ON ^{19}F, ^{53}Cr, ^{59}Co, ^{61}Ni, ^{62}Ni, ^{63}Cu AT THE PROTON ENERGY 6.8 MeV. Dryapachenko, I. P.; Kornilov, V. A.; Nemets, O. F.; Pilipchenko, V. A. (Inst. of Physics, Kiev). Yadern. Fiz., 6: 440-5(Sept. 1967). (In Russian).

By means of the time-of-flight method the spectra and angular distributions of neutrons from (p,n) reactions on ^{53}Cr, ^{59}Co, ^{61}Ni, ^{62}Ni, and ^{63}Cu at the proton energy 6.8 MeV were measured. By analyzing the spectra using the framework of statistical theory, it was shown that the compound-nucleus mechanism predominates. The character of angular distributions on ^{61}Ni and ^{59}Co shows the possibility of a small contribution of the direct-interaction process. The total cross sections of (p,n) reactions on ^{53}Cr, ^{58}Co, ^{61}Ni and ^{63}Cu were estimated. The neutron angular distribution from the reaction ^{19}F(p,n)^{19}Ne, the character of which supports the considerable role of direct interaction was also measured. (auth)

1633 THE ^{51}V(n,γ)^{52}V REACTION. Archer, N. P.; Kennett, T. J. (McMaster Univ., Hamilton, Ont.). Can. J. Phys., 45: 2683-94(Aug. 1967).

The gamma radiation following thermal neutron capture by vanadium was studied using a Ge(Li) detector. A separation energy of 7,311 ± 2 keV was determined and the ground-state triplet was observed, confirming levels of 17 and 23 keV. Coincidence measurements were used to assist in the construction of a decay scheme which includes 97% of the total observed intensity. The agreement with (d,p) measurements is very good and permits one to conclude that essentially all of the observed transitions are E1. The lack of any correlation between reduced radiation widths and stripping strengths suggests the absence of direct capture. (auth)

1634 MODERN EXPERIMENTAL NUCLEAR PHYSICS. Kamke, Detlef (Ruhr-Univ. Bochum, Ger.). Naturwiss. Rundsch., 20: 55-63(Feb. 1967). (In German).

A discussion of the fundamentals of experimental nuclear physics and an outline of the newer means of detection and measurement of particle and γ emission including a discussion of low-energy accelerators are given. The installation of an electrostatic tandem accelerator is described, and the principles are carried further for the description of a double tandem arrangement for the attainment of higher energies. In particular, the inclined field accelerator tube is discussed. Electronics and data handling for accelerators are described; multichannel analyzers and detectors for the measurement of the angular distribution from a source are introduced. A coincidence detector for studies of multiparticle decomposition is explained. An application of these techniques is given with the study of the reaction $^{35}Cl(p,\alpha)^{32}S$. Cross sections for the reaction at 170° are given, and the autocorrelation function at the same angle is illustrated. A new unknown region of higher excitation of ^{36}Ar is uncovered, in which there are a number of levels which appear to have a considerable width. (BBB)

1635 THE ^{51}V(n,γ)^{52}V REACTION. Archer, N.; Kennett, T. J. (McMaster Univ., Hamilton, Ont.). Can. J. Phys., 45: 2683-94(Aug. 1967).

The gamma radiation following thermal neutron capture by vanadium was studied using a Ge(Li) detector. A separation energy of 7311 ± 2 keV was determined and the ground-state triplet was observed, confirming levels of 17 and 23 keV. Coincidence measurements were used to assist in the construction of a decay scheme which includes 97% of the total observed intensity. The agreement with (d,p) measurements is very good and permits one to conclude that essentially all of the observed transitions are E1. The lack of any correlation between reduced radiation widths and stripping strengths suggests the absence of direct capture. (auth) (CANADA)

1636 PHOTOPROTON YIELDS FROM THE TITANIUM ISOTOPES. Pai, H. L.; McNeill, K. G. (Univ. of Toronto). Can. J. Phys., 45: 3235-40(Oct. 1967).

Measurements were made of the yields of protons ejected as the first particle after excitation of nuclei of the titanium isotopes by bremsstrahlung of 22- and 30-MeV energy. It is found that for ^{47}Ti, ^{48}Ti, and ^{49}Ti, a constant-temperature compound-nucleus model fits the experimental data, the nuclear temperature being the same as that found to give a good fit to (n,p) data. ^{50}Ti, however, has a relatively high yield, and it is suggested that this is due to direct emission. (auth) (CANADA)

1637 GAMMA RAYS FROM THE REACTION $^{55}Mn(p,n\gamma)^{55}Fe$. Iyengar, K. V. K.; Lal, B.; Gupta, S. K. (Tata Inst. of Fundamental Research, Bombay). Nucl. Phys., A103: 592-600(1967).

The 510 and 680 keV levels in ^{55}Fe reported by Kim do not seem to be generated in the $^{55}Mn(p,n\gamma)^{55}Fe$ reaction to intensities higher than 8% and 4% of the 413 keV level. The measurements were

done by observing the direct gamma radiations with a Ge(Li) detector with incident protons of energy 1.80 to 3.50 MeV. The measured angular distributions of the 933 and 1322 keV gamma rays at E_p = 2.40 and 3.50 MeV and that of the 1413 keV gamma rays at E_p = 3.50 MeV are in reasonable agreement with those calculated from the statistical model. The reaction proceeds through the compound nucleus, and the random phase approximation appears to be valid for the compound nucleus ^{56}Fe at these excitation energies. (auth)

1638 $\beta-\gamma$(CP) CORRELATION STUDIES OF ^{72}Ga AND SPIN ASSIGNMENTS IN ^{72}Ge. Tirsell, K. Glenn; Bloom, Stewart D. (Univ. of California, Livermore). Contract W-7405-eng-48. Nucl. Phys., A103: 461-73(1967). (UCRL-70181).

Using a transmission polarimeter, measurements were made of the $\beta-\gamma$ circular-polarization correlation parameter A for the 948 keV β-2202 keV γ-cascade in the decay of ^{72}Ga. The measured value A = -0.142 ± 0.026 is in good agreement with previous scattering polarimeter results. It and a 2^- assignment to the 3036 keV level in ^{72}Ga lead to δ(M2/E1) = $+0.036 \pm 0.039$ for the 2202 keV γ-ray, whereas 3^- yields the charge-dependent matrix element $|\langle H_C \rangle|$ = 45.9 ± 3.3 keV. On the basis of other published studies of ^{72}Ge, the 2^- assignment is strongly favored, and our results are completely consistent with this also. The value A = -0.019 ± 0.018 was measured for the combined 642 keV β-2508 keV γ and 659 keV β-2491 keV γ-cascades. With the assignment of 3^- to the 3342 keV level and 2^- to the 3325 keV level this result yields, for the $\Delta J = 0$ transition involving the 2508 keV γ-ray, the value $(7.4 \pm 2.3) \times 10^{-3}$ for the Fermi matrix element, $|M_V|$, and $|\langle H_C \rangle|$ = 22.8 ± 7.9 keV. These assignments are favored on the basis of an analysis of the γ-ray transition probabilities plus other available evidence. The data are also analyzed for alternative assignments to these levels. (auth)

1639 SHORT-LIVED PRODUCTS IN 12.5 MeV DEUTERON BOMBARDMENT OF CHROMIUM. Svoboda, K.; Hruby, J.; Hradil, M. (Inst. of Nuclear Research, Czechoslovak Academy of Sciences, Rez). Isotopenpraxis, 3: 313-17(1967). (In German).

The short-lived products of the nuclear reactions in Cr bombarded with 12.5 MeV deuterons were studied. ^{52m}Mn and ^{51}Mn were determined. For identifications the gamma-ray spectra and the half-lives were measured. Moreover, saturation activities per microampere of ^{52m}Mn (30.5 mCi/μA), ^{51}Mn (4.1 mCi/μA), and ^{52}Mn (13.4 mCi/μA) were determined. A formula for the calculation of the total gamma-ray intensity of the Cr target valid for any bombardment and cooling period as well as a nomogram for its evaluation is presented. (auth)

1640 THE ^{63,65}Cu(^{3}He,d)^{64,66}Zn REACTIONS. Ford, J. L. C. Jr.; Warsh, K. L.; Robinson, R. L.; Moak, C. D. (Oak Ridge National Lab., Tenn.). Contract W-7405-eng-26. Nucl. Phys., A103: 525-44(1967). (ORNL-P-3258).

Excited levels of ^{64}Zn and ^{66}Zn were investigated by means of the (^{3}He,d) reaction at an incident energy of 18 MeV. Angular distributions were measured, and distorted wave calculations performed for excitation energies up to about 3 MeV. The ground states and first and second 2^+ states at 0.99 and 1.80 MeV in ^{64}Zn and at 1.04 and 1.87 MeV in ^{66}Zn appear to be largely due to orbital angular momentum transfers of l = 1. The known 0^+ states at 1.90 and 2.62 MeV in ^{64}Zn and at 2.38 MeV in ^{66}Zn, the 4^+ states at 2.32 MeV in ^{64}Zn and at 2.46 MeV in ^{66}Zn and the possible 3^- states at 3.00 MeV in ^{64}Zn and at 2.81 MeV in ^{66}Zn have angular distributions consistent with l = 1, 3, and 4, respectively. Distorted wave calculations were performed with and without finite range and non-local potentials, and spectroscopic factors determined. (auth)

1641 RADIATIVE ALPHA CAPTURE BY ^{38}Ar AND ^{36}Ar. Nahm, C. W.; Thwaites, T. T. (Pennsylvania State Univ., University Park). Nucl. Phys., A103: 503-12(1967).

The ^{38}Ar(α,γ)^{42}Ca and ^{36}Ar(α,γ)^{40}Ca reactions were studied from 3.0 to 6.0 and 3.0 to 5.7 MeV alpha energy, respectively. At least 59 resonances were identified in the ^{38}Ar(α,γ)^{42}Ca reaction and 23 of them were shown to be 1^-. One resonance near E_α = 5.619 MeV appears to have been identified in the ^{36}Ar(α,γ)^{40}Ca reaction. (auth)

1642 REACTIONS (p,2p) AT 156 MeV. III. ^{23}Na, ^{24}Mg, ^{28}Si, ^{64}Zn, ^{75}As, AND ^{90}Zr. Arditi, M.; Doubre, H.; Riou, M.; Royer, D.; Ruhla, C. (Institut de Physique Nucleaire, Orsay, France). Nucl. Phys., A103: 319-36(1967).

Quasi-free proton-proton scattering was studied at 156 MeV using two magnetic spectrometers, localization spark chambers, and an on-line computer. The overall energy resolution is 1.7 to 2.2 MeV. Summed energy spectra and angular distributions of components of these spectra are given. Assignments for $(1d_{\frac{5}{2}})^{-1}$, $(2s_{\frac{1}{2}})^{-1}$, $(1p_{\frac{3}{2}})^{-1}$ and $(1p_{\frac{1}{2}})^{-1}$ states in ^{23}Na, ^{24}Mg, and ^{28}Si, $-(2p_{\frac{3}{2}})^{-1}$ and $(2s_{\frac{1}{2}})^{-1}$ states in ^{64}Zn, $(2p_{\frac{3}{2}})^{-1}$ and $(1f)^{-1}$ states in ^{75}As and ^{90}Zr were deduced. (auth)

Nuclear Properties and Reactions, A ≥ 90

Refer also to abstracts 943, 1581, 1706, 1712, 1734, 1735, 1746, 1747, and 1915.

1643 (AD-646588) DECAY CHARACTERISTICS OF ^{146}Pm. Bunney, Leland R.; Scadden, Edith M. (Naval Radiological Defense Lab., San Francisco, Calif.). Feb. 7, 1967. 19p. CFSTI.

The half-life of ^{146}Pm was determined to be 2020 plus or minus 18 days. The radionuclide was produced by a (p,n) reaction on enriched ^{146}Nd. The decay of the purified ^{146}Pm was followed on both beta-ray and gamma-ray counters. The gamma-ray energies were determined from pulse-height distribution curves obtained with a Ge (Li) detector. Prominent gamma rays with energies of 453, 736, and 747 keV and low-abundance gamma rays with energies of 146, 589, 634, and 1189 keV were observed. (auth) (TAB)

1644 (AD-647902) RESEARCH IN EXPERIMENTAL AND THEORETICAL LOW-ENERGY NUCLEAR PHYSICS. Final Report, October 1, 1965-September 30, 1966. Davis, R. H.; Heydenburg, N. P. (Florida State Univ., Tallahasee. Tandem Accelerator Lab.). Sept. 30, 1966. Contract AF-AFOSR-440-66. 71p. (AFOSR-67-0608). CFSTI.

Nine research groups involving eleven faculty members used the tandem Van de Graaff accelerator to advance scientific knowledge in the following areas: isobaric analogue states, alpha-particle interactions, spectroscopy of the $f_{\frac{7}{2}}$ shell, nucleon transfer and direct reactions, Coulomb excitation, collective excitation mechanisms, charged particle-induced fission, and atomic high-energy conversion processes. The study of the isobaric analogue states which was initiated at this laboratory, was the subject of an international conference held in Tallahassee in March, 1966. An active program in theoretical nuclear physics is part of the tandem accelerator research program. In addition to collaboration in the design of experiments and the analysis of the results, fundamental problems in nuclear reactions were investigated by the theory group. The accelerator technology of the system was advanced during the past year with the replacement of several vacuum stations and the preliminary test of potassium vapor exchange which is especially important for the production of negative helium ions. Under optimum conditions an alpha-particle beam of 0.5 microamperes is available for experimental use. (auth)

1645 (AWRE-O-43/67) PROMPT NEUTRON EMISSION FROM ^{235}U FISSION FRAGMENTS. Maslin, E. E.; Rodgers, A. L.; Core, W. G. F. (Atomic Weapons Research Establishment, Aldermaston (England)). June 1967. 34p. Dep. CFSTI. UK 5s. 0d.

A description is given of measurements of the prompt-neutron emission from fission fragments of ^{235}U in thermal neutron-induced fission. A beam of neutrons from the AWRE research reactor HERALD induces fissions in a thin (20 μg/cm^2) sample of ^{235}U. Neutrons are detected in a large (250 liters) liquid scintillation counter, and the fragment kinetic energies are measured with gold-silicon surface barrier counters. Distributions showing the neutron emission from both individual fission fragments and from pairs of fragments are given as functions of both the mass of the fragment and the total kinetic energy of the pair. (auth)

1646 (IS-1683) PRECISE MEASUREMENT OF THE INTERNAL CONVERSION COEFFICIENT OF THE 45-keV TRANSITION IN ^{236}U. Duke, Charles Lewis; Talbert, W. L. (Ames Lab., Iowa). Aug. 1967. Contract W-7405-eng-82. 80p. Dep. CFSTI.

The total internal conversion coefficient of the 45-keV $2^+ \rightarrow 0^+$ transition in ^{236}U was measured by analysis of photon spectra observed, using a well-type NaI(Tl) detector, in coincidence with the 5.115-MeV alpha group from the decay of ^{240}Pu. The alpha spectra from the gating detector were analyzed on a computer using a least squares curve-fitting program to correct for the contribution to the gating from the 5.159-MeV ground-state alpha group. The NaI(Tl) photon efficiency for the transition was calculated using a computer program that included angular correlation effects. The result for the total internal conversion coefficient of the 45-keV E2 transition in ^{236}U was 607 ± 29. This value is in agreement with the theoretical calculations of Rose and Sliv and Band. A

pile-up rejection circuit developed for this investigation is described. (auth)

1647 (ISS-67/22) SULL'ATTIVAZIONE DEL ^{111}Cd MEDIANTE DIFFUSIONE DI γ IN RISONANZA. (Activation of ^{111}Cd by γ-Rays Scattering in Resonance). Canella, G. (Istituto Superiore di Sanita, Rome (Italy). Laboratori di Fisica). Sept. 4, 1967. 20p. (In Italian). Dep.

Specific activation of ^{111}Cd versus irradiated sample thickness by ^{60}Co γ-ray source was calculated and experimentally shown. The ^{111}Cd activation level was found in practice superposed on the 1.332 MeV level of ^{60}Co γ-ray emission. (auth)

1648 (ITF-67-9) KOLLEKTIVNYE VOZBUZHDENIYA CHETYKH ATOMNYKH YADER. (Collective Excitations of Even-Even Atomic Nuclei). Davydov, A. S. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1967. 92p. (In Russian). Dep.

A review is presented of the principal theoretical investigations of the collective excited states of even-even nuclei. The problem of classification of the excited states in spherical and non-spherical nuclei is studied. Attention is drawn to the phenomenological theory of quadrupole excited states. Different approximations are investigated for this theory. It is shown how in the phenomenological theory the energies of excited states and the probabilities of electromagnetic transitions between them are expressed in terms of a number of parameters characterizing the nuclear shape in the ground state and its deformability. An outline of the theory of the octupole excited states is given. The connection between the phenomenological theory and a "microtheory" of collective excitations is pointed out. (auth)

1649 (JINR-P6-3452) RASPAD ^{170}Lu. (Decay of ^{170}Lu). Bonch-Osmolovskaya, N. A.; Vrzal, Ya.; Grigor'ev, E. P.; Zaitseva, N. G.; Liptak, Ya.; Tishin, V. G.; Urbanets, Ya. (Joint Inst. for Nuclear Research, Dubna (USSR)). 1967. 29p. (In Russian). Dep.

The γ-ray spectra from ^{170}Lu decay was measured and the ^{170}Lu decay scheme constructed and analyzed. (auth)

1650 (JINR-P6-3471) ISSLEDOVANNE RASPADA IZOTOPOV PROMETIEVOI FRAKTSII. (Investigation of the Decay of the Pm Fraction Isotopes). Avotina, M. P.; Grigor'ev, E. P.; Zolotavin, A. V.; Sergeev, V. O.; Sovtsov, M. I.; Vrzal, Ya.; Lebedev, N. A.; Liptak, Ya.; Urbanets, Ya. (Joint Inst. for Nuclear Research, Dubna (USSR)). 1967. 22p. (In Russian). Dep.

Gamma-ray and internal-conversion electron spectra of the Pm isotopes with A = 143, 144, 146, and 148 were investigated by using a semiconductor Ge(Li) γ-spectrometer and a double-focusing β-spectrometer. A number of new transitions was found and the multipolarities of some transitions are determined. (auth)

1651 (JINR-P6-3494) IZMERENIE β^+-p-SOVPADENII DLYA IZLUCHATELYA ZAPAZDYVANYUSHCHIKH PROTONOV ^{111}Te. (Measurement of β^+-p-Coincidences for ^{111}Te Delayed Proton Emitter). Bacho, I.; Bogdanov, D. D.; Daroczy, S.; Karnaukhov, V. A.; Petrov, L. A. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Reactions). 1967. 17p. Dep. (In Russian).

Delayed protons of ^{111}Te ($T_{1/2}$ = 19.5 sec) which is produced by the reaction ^{102}Pd(^{12}C,3n) were studied. The proton spectra were measured simultaneously in coincidence with positrons and without coincidences. These spectra essentially differ since the coincidences single out only the positron branch of the ^{111}Te decay. The intensity ratio in these two spectra is determined by the probability ratio of positron decay and K-capture of ^{111}Te into the proton-unstable states of ^{111}Sb. The measured ratios of the proton intensities were compared with the calculated ratios. From the condition of the best fit the value $Q_0 - \beta_p = 5.07 \pm 0.07$ MeV is obtained, where Q_0 is the energy of K-capture of ^{111}Te and B_p the binding energy of a proton in ^{111}Sb. This value is in the best agreement with the calculations made using the Zeldes' and Garvey-Kelson's formulas. (auth)

1652 (JINR-P6-3496) O SKHEME RASPADA ^{158}Er. (On the Decay Mode of ^{158}Er). Abdurazakov, A. A.; Gromov, K. Ya.; Zhelev, Zh. T.; Kalinnikov, V. G.; Liptak, Ya.; Nazarov, U. K.; Urbanets, Ya. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1967. 13p. (In Russian). Dep.

Gamma-ray and conversion electron spectra, and β^+-decay of ^{158}Er were investigated. New γ-transitions of 270, 294.1, and 341.6 keV were observed. New levels of energies 160.3(2$^-$), 408.9 keV(1$^+$), and 425.6 keV(1$^-$) were introduced into the decay mode of ^{158}Er. The multipolarities of transitions were determined to be 386.9, 358.3, and 341.6 keV. The multipolarities of some other γ-transitions are estimated. Quantum characteristics of 67.2 keV (2$^-$) and 454.2 keV(1$^-$) levels are determined. The mass difference of ^{158}Er and ^{158}Ho nuclei is found to be (1860 ± 60 keV). The decay mode of ^{158}Er is discussed. (auth)

1653 (JUL-491-PC) BESTIMMUNG DER SPEZIFISCHEN α-AKTIVITAET DES ^{233}U MIT HILFE EINER FLUESSIGSZINTILLATIONSZAEHLMETHODE. (Determination of the Specific α-Activity of ^{233}U with the Help of a Liquid Scintillation Counter Method). Ihle, H. R.; Langenscheidt, E.; Murrenhoff, A. P. (Kernforschungsanlage, Juelich (West Germany). Institut fuer Physikalische Chemie). June 1967. 57p. (In German). Dep.

By use of an improved liquid scintillation counting method the specific α activity of ^{233}U was determined to be 21,014 ± 42 disintegrations · min^{-1} · μg^{-1}, which corresponds to a half-life of 162,100 ± 320 years. The final purification of the ^{233}U source used in this work was carried out by a solvent extraction method, which allows the separation of a great number of impurity elements from uranium by a simple procedure. (auth)

1654 (LA-3738) SYNTHESIS OF NEUTRON-RICH NUCLIDES. Cowan, George A. (Los Alamos Scientific Lab., N. Mex.). July 1967. Contract W-7405-eng-36. 8p. (CONF-670401-13). Dep. CFSTI.

From 153rd National Meeting, American Chemical Society, Miami Beach, Fla.

The technique of multiple neutron capture in nuclear explosives is compared with alternative methods for the production of heavy elements. Some recent data from the "Cyclamen" experiment are cited to summarize the present state-of-the-art and prospects for further progress are reviewed. (auth)

1655 (NAA-SR-12515) CALCULATIONS OF ^{239}Pu RESONANCE CROSS SECTIONS USING FISSION WIDTHS FROM CHANNEL FISSION THEORY. Otter, J. M. (Atomics International, Canoga Park, Calif.). Oct. 1, 1967. Contract AT(04-3)-701. 37p. Dep. CFSTI.

Multigroup cross sections for ^{239}Pu are calculated using standard single-level isolated line shapes, but with different average fission widths for each (l,J) series rather than equal ones, as has been common practice. The average fission widths and the degrees of freedom in the distributions were calculated from channel fission theory. Using the l = 1 strength function, the number of open channels for the (0,0) series, and the average fission width at E = 0 for the (0,1) series as parameters, acceptable fits to experimental curves of σ_f and $\alpha = \sigma_c/\sigma_f$ were found in the 40-eV to 250-keV range. The Doppler effect for a typical fast critical assembly was calculated and was found to be less than 25% of that obtained in the equal fission width mode. The two fission widths could only be optimized as a set pending better measurements of α below 10 keV, and/or Doppler coefficients. Multilevel and overlap effects are discussed and are shown to be probably not serious problems for ^{239}Pu. (auth)

1656 (UCRL-17699) ELECTRON PARAMAGNETIC RESONANCE STUDIES OF RADIOACTIVE TRANSITION-METAL IONS. Easley, Warren Cliett (California Univ., Berkeley. Lawrence Radiation Lab.). Aug. 1967. Contract W-7405-eng-48. 153p. Dep. CFSTI.

Thesis.

Electron paramagnetic resonance (EPR) was observed in 253-day ^{110m}Ag, present as Ag^{2+} in the $[(iso\text{-}C_3H_7)_2NCS_2]_2$ Ag complex. Eleven hfs (hyperfine structure) lines were observed, the positions of the other two lines being obscured by other absorptions present in the sample, and the nuclear spin of 6 was confirmed. A hfs constant $a_{110m} = 7.108 \pm 0.02 \times 10^{-3}$ cm^{-1} was determined. A hyperfine anomaly of $\Delta_{107,109} = -0.40\% \pm 0.1\%$ was observed for stable Ag^{2+} in this complex, indicating that the hfs arises from contact interaction. A nuclear moment of $\mu_{110m} = +3.55 \pm 0.04$ nm was derived after a 3.7% hyperfine-anomaly correction. The nuclear moment does not agree with shell-model predictions using empirical g factors, being low by 1 nm. It is suggested that the $(g_9)^7$ proton configuration might be coupled to spin $^9/_2$. This yields a moment of +3.54 nm. EPR experiments on yttrium ethylsulfate single crystals containing terbium isotopes in the ratios ^{159}Tb/^{157}Tb/^{158}Tb = 25/1.6/1 were carried out at Q-band frequencies (35 GHz). The nuclear spin of ^{158}Tb was found to be 3 and by comparison with the observed hyperfine structure of ^{159}Tb and its known nuclear moment, a magnetic moment $^{158}\mu = 1.740 \pm .007$ nm was calculated. Transitions due to ^{157}Tb were not observed, presumably because they were obscured by the stronger ^{159}Tb lines. Assuming $^{159}I = {}^{157}I = {}^3/_2$, the following limits were set on the value of $^{157}\mu$: $1.88 \leq {}^{157}\mu \leq 2.10$. ^{160}Tb lines were also observed in YES single crystals. They gave $^{160}\mu = 1.685 \pm .008$ nm. Nuclear alignment experiments on ^{158}Tb in a single crystal of neodymium ethylsulfate were also carried out in order to determine a relation between the quadrupole coupling constant and the magnetic hyperfine structure constant. This information, as

well as existing nuclear orientation results on ^{160}Tb, was combined with the EPR data to obtain quadrupole coupling constants. Quadrupole moments calculated from the coupling constants were found to be: $^{158}Q = 2.7 \pm 0.5$ barns and $^{160}Q = 3.0 \pm 0.5$ barns. The first well-verified divalent actinide ion, Am^{2+} ($5f^7$, nominal $^8S_{7/2}$), was stabilized in a calcium fluoride single crystal and characterized by EPR and optical spectroscopy. Reduction of the trivalent ion was obtained by solid-state electrolysis and/or as a result of the emission of ionizing α-radiation during the americium nuclear decay. The radiation-reduced crystals were observed to thermoluminesce at 500°C; emitting radiation characteristic of the Am^{3+} ion. The electrolytically reduced crystals did not thermoluminesce. EPR measurements at liquid helium temperatures showed the Γ_8 crystal-field state to be lowest in energy. The X-band EPR spectra were fitted with the following spin Hamiltonian parameters: $|g| = 4.490 \pm 0.002$, $|A|$ (^{243}Am) $= 1.821 \pm 0.002 \times 10^{-2}$ cm^{-1}, $|A|$ (^{241}Am) $= 1.837 \pm 0.002 \times 10^{-2}$ cm^{-1}, $^{241}I = ^{243}I = 5/2$. Analysis of the americium hfs allowed the determination of a contact hfs constant (corrected for the effect of the crystal field) $a_c = -9.01 \times 10^{-3}$ cm^{-1}. This is equivalent to a hyperfine magnetic field per unpaired 5f electron of (−) 285 kilogauss. Measurements on isoelectronic $^{244}Cm^{3+}$ ($I = 0$) at sites of cubic symmetry were also carried out, yielding an isotropic g value which agreed within experimental error with that of Am^{2+}. Two charge-compensated sites with trigonal symmetry about the [111] axes of the cube were also observed. The components of the g tensors were found to be: $g_{||}$ (site I) $= 3.41 \pm 0.02$, $g_\perp$ (site I) $= 6.88 \pm 0.02$ $g_{||}$ (site II) $= 2.69 \pm 0.02$, $g_\perp$ (site II) $= 5.91 \pm 0.02$. Subsequent studies at Q-band frequencies allowed the cubic crystal-field splittings to be determined. The splitting between the ground Γ_8 state and the first excited Γ_8 state was found to be 13.4 ± 0.5 cm^{-1} and 18.6 ± 0.5 cm^{-1} for Cm^{3+} and Am^{2+} at cubic sites in CaF_2, respectively. The splittings are shown to be due primarily to the effects of intermediate coupling on the ground-state wave function. (auth)

1657 (UCRL–17716) MAGNETIC HYPERFINE FIELD, NUCLEAR g-FACTOR, AND SPIN-LATTICE RELAXATION FOR ^{125}Sb IN IRON FROM NUCLEAR ORIENTATION-NMR. Barclay, J. A.; Brewer, W. D.; Matthias, E.; Shirley, D. A. (California Univ., Berkeley. Lawrence Radiation Lab.). Aug. 1967. Contract W-7405-eng-48. 12p. (CONF-670812–15). Dep. CFSTI.

From International Conference on Hyperfine Interactions, Pacific Grove, Calif.

The method of nuclear orientation nuclear magnetic resonance was applied to the determination of the magnetic hyperfine field, nuclear g-factor, and spin–lattice relaxation time of ^{125}Sb embedded in a lattice of Fe. The sources used in these experiments were prepared by depositing 1 to 2 μC of ^{125}Sb onto Fe foils and melting the samples to obtain solid solutions of less than 1 part Sb in 10^4 parts Fe. (S.F.L.)

1658 (UCRL-Trans–10130) STUDY OF SHORT-LIVED FISSION PRODUCTS BY MEANS OF AN ISOTOPE SEPARATOR CONNECTED TO A REACTOR. Crancon, J.; Moussa, A. (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). Translated by Benjamin Thayne for Lawrence Radiation Lab., Univ. of California, Livermore, from report CH-N–65-09. 74p. Dep. CFSTI. JCL $7.60 fs, $2.48 mf.

A project for the study of short-lived fission products using an isotope separator connected with a tangential channel of the Melusine reactor is outlined. Among the measurements envisaged for this project are determination of half lives, identification of mass numbers, research and study of previously undetected nuclei, determination of yields independent of fission, determination of branching ratios, and β and γ spectrometry. The principles of the project are given. The problems to be considered in the design of the project are target arrangement, chemical separations, transport of fission products, separation and collection of ions, measurement equipment, estimation of intensities, and contamination problems. The experimental program is outlined with the consideration of the cost and the personnel needs. (J.S.R.)

1659 THE SPONTANEOUS FISSION HALF-LIFE OF ^{250}Cm. Metta, D. N.; Moreland, P. E. (Argonne National Lab., Ill.). J. Inorg. Nucl. Chem., 29: 2822-3(Nov. 1967).

A value of $1.74 \pm 0.24 \times 10^4$ yr has been reported for the spontaneous fission half-life of ^{250}Cm, employing Cm resulting from the PAR thermonuclear explosion. This determination depended on a mass spectrometric measurement of the isotopic composition of the PAR Cm, using only very small samples, in an effort to preserve the bulk of the Cm for further experiments; as a result, the 250 Cm abundance could not be accurately measured. Subsequently a much larger sample was used, to obtain a more reliable isotopic analysis. The sample of PAR curium was repeatedly separated from Cf by α-hydroxybutyrate cation columns and saturated HCl-ethanol anion columns. A fission rate of 0.1565 ± 0.0017 fission/min and an alpha αpm value of 4.127 ± 0.006 were observed for the sample. The spontaneous fission rate due to ^{242}Cm, ^{246}Cm, and ^{248}Cm combined was 0.0550 ± 0.0018 fission/min. The resultant spontaneous fission half-life for ^{250}Cm is $1.13 \pm 0.05 \times 10^4$ yr. (UK)

1660 HALF-LIFE OF ^{210}Pb(RaD). von Gunten, H. R.; Wyttenbach, A.; Dulakas, H. (Eidgenoessisches Inst. fuer Reaktorforschung, Wurenlingen, Switzerland). J. Inorg. Nucl. Chem., 29: 2826-9(Nov. 1967).

Lead-210 is used extensively in geochronometric studies; hence, it is a requirement that its half-life be known as accurately as possible. Published values range from 16.5 to 25.4 yr, with an average value of 22.2 yr. The method employed by the present authors consisted in the radiometric measurement of the growth of ^{210}Pb into solutions of pitchblende minerals after complete extraction of the Pb originally present in the mineral. Experimental details are described, and the results are tabulated. The average of 21 half-life determinations was 22.2 ± 1.0 yr. A check was made to verify the assumption of secular equilibrium in the minerals employed. (UK)

1661 CALORIMETRICALLY MEASURED HALF-LIFE OF ^{170}Tm. Kerrigan, W. J. (E. I. du Pont de Nemours and Co., Aiken, S. C.). Contract AT(07-2)-1. J. Inorg. Nucl. Chem., 29: 2657-8(Nov. 1967). (DP-MS–67-39).

A half-life of 128 ± 1 days for ^{170}Tm was determined calorimetrically. Two ^{170}Tm sources of about 1 W each were measured for 140 days. The sources were produced by neutron irradiation of $^{169}Tm_2O_3$ wafers, to a specific power of ~2W/g. The absence of interfering radioisotopes was verified by gamma and mass spectrometry. (auth) (UK)

1662 A CALORIMETRIC DETERMINATION OF THE SPECIFIC POWER AND HALF-LIFE OF ^{241}Am. Oetting, Franklin L. (Dow Chemical Co., Golden, Colo.); Gunn, Stuart R. J. Inorg. Nucl. Chem., 29: 2659-64(Nov. 1967).

The specific power output from ^{241}Am was determined on two separate samples of Am metal with several calorimeters. The measured specific power of 0.1145 W/g was used to calculate the half-life of ^{241}Am as 432.7 ± 0.7 yr. This calorimetric value is significantly different from the half-life of 458.0 yr as determined by absolute alpha (specific activity) low geometry counters as reported in the literature. This new value for ^{241}Am half-life will change the half-life of ^{241}Pu, whose half-life calculation is dependent upon the ^{241}Am half-life. The new beta half-life for ^{241}Pu is 14.03 ± 0.30 yr. (auth) (UK)

1663 THERMAL NEUTRON CROSS-SECTIONS AND RESONANCE INTEGRALS OF THE EUROPIUM ISOTOPES. Sims, G. H. E.; Juhnke, D. G. (Atomic Energy of Canada Ltd., Ottawa). J. Inorg. Nucl. Chem., 29: 2671-7(Nov. 1967).

The effective neutron capture cross sections of ^{151}Eu and ^{153}Eu were measured by an activation method with and without a cadmium cover. Using the Westcott convention the 2200 m/sec cross sections and the resonance integrals Σ and Σ' were calculated assuming the cross sections obey a $1/v$ law in the thermal region. The measured cross section value of $2,951 \pm 85$ barn for the production of ^{152m}Eu (9.3-hr half-life) is based on a cross section of 98.8 barns for ^{197}Au. The values of $4,410 \pm 66$ barn for the production of ^{152}Eu (12.4-yr half-life) and 639 ± 7 barn for the production of ^{154}Eu are based on a cross section of 37.5 barn for ^{59}Co. The respective resonance integrals are $11,410 \pm 450$ barn, $3,847 \pm 270$ barn and $3,887 \pm 62$ barn. Quoted errors are at the 95% confidence level. The effect of neutron self-shielding on the measurements was determined, and sample weights were chosen to reduce this effect to negligible proportions. (auth) (UK)

1664 NUCLEAR DATA SHEETS. (Oak Ridge National Lab., Tenn.). Nucl. Data, Sect. B, 2: B2-2-1-122(Aug. 1967).

A compilation of recent references is presented for publications on experimental decay and level properties of nuclei in the range A = 21 to 228. An arrangement of "key numbers" with associated subjects is provided for convenient searching of the material. (S.F.L.)

1665 FISSION OF THORIUM AND URANIUM BY 15-MeV NEUTRONS. Goennenwein, F.; Pfeifer, E. (Univ., Tuebingen, Ger.). Z. Phys., 207: 209-24(1967).

A two-parameter experiment on fission induced by 15 MeV neutrons in natural Th and U is reported. The measurements were made at 0 and 90° relative to the neutron beam, using two surface barrier detectors facing each other. From the double energy data the overall distributions in energy, mass and angle were obtained. Conditional distributions for energy and angle with the mass as parameter were also extracted. Results for Th: total kinetic energy release $\overline{E^*_T} = 165.5 \pm 3.0$ MeV, anisotropy $Y(0°)/Y(90°) = 1.70 \pm$

0.05. Results for U: $\overline{E_f^*}$ = 168.6 ± 3.0 MeV, Y(0°)/Y(90°) = 1.32 ± 0.04. The results are discussed in terms of currently available models of fission: fragment shell theories and the two-mode-fission-hypothesis. (auth)

1666 MOESSBAUER EFFECT MEASUREMENTS WITH THE 79.5-keV LEVEL OF ^{158}Gd. Fink, Joerg (Technische Hochschule, Munich). Z. Phys., 207: 225-34(1967). (In German).

Mössbauer effect measurements with the 79.5 keV γ-transition in ^{158}Gd, populated by thermal neutron capture in ^{157}Gd are reported. In Gd metal, GdF_3 and $GdCl_3$, the values obtained for the electric field gradient are (–0.7 ± 0.4), (11.9 ± 5.0) and (–7.5 ± 0.5) × 10^{17} V/cm^2 respectively. The internal magnetic field in Gd metal was measured to be H_{int} = 312 ± 23 kG and the g factor of the 2+ level was found to be g_R = 0.385 ± 0.022. The change of the mean square nuclear radius between the ground state and the first excited state $\Delta\langle r^2\rangle$ = +(0.4 ± 0.3) × 10^{-3} fm^2, as extracted from the measurements, will be compared with model calculations of nuclear rotation. (auth)

1667 SPECTROSCOPIC STUDIES IN SCS AND (SCS-1) NUCLEI WITH A Ge(Li) DETECTOR. Goldman, D.; Miyao, Y.; Nascimento, I. C.; da Costa, N. L.; de Barros Leite, C. V.; de Pinho, A. G. (Univ., Sao Paulo. Pontificia Univ. Catolica, Rio de Janeiro). An. Acad. Brasil. Cienc., 39: 89-116(Mar. 1967).

The energy levels of some nuclei with a closed outer shell or with a single hole in this shell were investigated. Gamma spectra in the decay of some In and Sn isotopes and in the decay of ^{139}Pr and ^{143}Sm were measured using a Ge(Li) detector. Several previously unreported transitions were observed in the decays of ^{116}In, ^{139}Pr, ^{143}Sm, and ^{111}Sn; the energies and intensities of a number of transitions in the decays of ^{116}In and ^{116}Sn were determined with greater precision than was previously reported. Seven levels were identified in ^{111}In between 1.0 and 2.4 MeV; the levels are fed by electron capture with log-ft values less than 6.0. It was found that ^{139}Ce has many odd-parity levels and that some of the levels in ^{143}Pm above 1 MeV have odd parity. (D.C.W.)

1668 VARIATION OF MASS DISTRIBUTIONS OF ^{238}U FISSION FRAGMENTS WITH NEUTRON ENERGY. Borisova, N. I.; Dubrovina, S. M.; Novgorodtseva, V. I.; Pchelin, V. A.; Shigin, V. A.; Shubko, V. M. Yadern. Fiz., 6: 454-61(Sept. 1967). (In Russian).

The yields of ^{238}U fission products which determine the shape of the fragment mass distribution curve in the energy range of monoenergetic neutrons from 1.5 to 18 MeV were measured. The yields of the symmetrical fission product ^{115}Cd and of the strongly asymmetrical fission product ^{77}As are respectively $1/_{800}$ and $1/_{2300}$ at 1.5 MeV; $1/_{80}$ and $1/_{400}$ at 5 MeV; $1/_7$ and $1/_{160}$ at 18 MeV in the units of the yield of asymmetrical fission products ^{99}Mo and ^{140}Ba. The experimental results indicate a determinative effect on the fragment yield from the individual properties of fission fragments, e.g., the rigidity to deformation, their equilibrium shape, the binding of nucleons, the density of excited levels. (auth)

1669 EFFECTIVE MOMENTA OF INERTIA OF HEAVY NUCLEI AT THE SADDLE POINT. Karamyan, S. A.; Kuznetsov, I. V.; Muzychka, Yu. A.; Oganesyan, Yu. Ts.; Penionzhkevich, Yu. E.; Pustyl'nik, B. I. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz., 6: 494-504(Sept. 1967). (In Russian).

Irradiating the targets of ^{197}Au, ^{209}Bi, and ^{238}U by accelerated ions ^{12}C, ^{14}N, ^{16}O, and ^{22}Ne with the energy from 6 up to 8 MeV nucleon the angular distributions of fission fragments were investigated. For any combination of target and particle and at any energy of bombarding ions, the angular dependence of the elastic scattering cross section was measured. From the elastic scattering data, the partial cross sections of compound-nucleus production were determined. Using these cross sections, on the basis of statistical model, the effective momenta of inertia of nuclei with Z^2/A from 35 up to 40 were calculated. It has been shown that the value J_{eff} within the accuracy of the experiment depends only on Z^2/A and does not depend on the temperature of nucleus. $(Z^2/A)_{cr}$ obtained from the extrapolation of experimental data lies within 45 to 47. (auth)

1670 PRODUCTION PROBABILITIES OF SPONTANEOUSLY FISSILE ISOMERS. Zommer, V. P. Yadern. Fiz., 6: 488-93 (Sept. 1967). (In Russian).

Relations between possible values of the energy and spin of the spontaneously fissile isomers ^{240m}Am and ^{242m}Am are found by analyzing the experimental data on their production probabilities. The minimal possible value of the spin of the spontaneously fissile isomer ^{242m}Am is estimated. (auth)

1671 FINE STRUCTURE OF A DOORWAY STATE IN ^{207}Pb. Lejeune, A. (Univ., Liege); Mahaux, C. Z. Phys., 207: 35-46 (1967).

The fine structure observed at Duke University in the total neutron cross section of ^{206}Pb is analyzed in terms of the K- and S-matrix parametrizations. The distributions of the resonance parameters are in fairly good agreement with the theoretical ones derived from a doorway-state hypothesis, combined with the picket-fence model. Attention is drawn to the fact that the average cross section usually allows only a very inaccurate determination of the parameters of the doorway-state resonance. (auth)

1672 ISOMERIC CROSS SECTION RATIO FOR ^{110}Pd(n,2n) ^{109}Pd REACTION AT 14.7 MeV. Minetti, B.; Pasquarelli, A. (Politecnico, Turin). Z. Phys., 207: 132-7(1967).

The reaction ^{110}Pd(n,2n)^{109}Pd was investigated using 14.7-MeV neutrons. Cross sections for the formation of ^{109m}Pd and ^{109g}Pd were measured. Experimental value of the isomeric cross section ratio was compared with the theoretical calculation performed with the Huizenga and Vandenbosch method. (auth)

1673 ON THE DECAY OF ^{147}Nd. Dougan, P. W.; Erlandsson, B. (Univ. of Lund, Sweden). Z. Phys., 207: 105-10(1967).

Gamma transitions in the deacy of ^{147}Nd were studied using a Ge(Li) spectrometer. The results of determinations of gamma energies and intensities are presented and compared to other recently reported data. (auth)

1674 EXCITED STATES IN ^{115}In. McDonald, J.; Porter, D.; Stewart, D. T. (Glasgow Univ.). Nucl. Phys., A104: 177-88 (1967).

The energy levels in ^{115}In were studied from the β^- decay of ^{115g}Cd and ^{115m}Cd and by Coulomb excitation of ^{115}In using helium ions and oxygen ions. The half-lives of the levels at 829 and 864 keV were determined by the $\beta\gamma$ delayed coincidence method. The K-conversion coefficient for the 864 → 829 keV transition was measured using a Si(Li) detector in a coincidence arrangement. Upper limits were placed on the half-lives of the levels at 934 and 1419 keV; Ge(Li) detectors were used in the Coulomb excitation experiments and B(E2) values extracted for the levels at 934, 1078, 1133, 1291, 1419, and 1450 keV and for a proposed level at 1645 ± 8 keV. A 199 keV gamma ray seen in the Coulomb excitation was assigned to an 1133 → 934 keV transition. The nature of the upper levels is discussed first in terms of the coupling of the proton hole to vibrations of the core and also in terms of a rotational band based on the 864 keV level. (auth)

1675 DETERMINATION OF THE INTRINSIC QUADRUPOLE MOMENT OF ^{162}Er FROM A PHOTOELECTRIC MEASUREMENT OF THE ISOTOPIC SHIFTS OF THE Er I AND Er II LINES. Cajko, J.; Textoris, R. (Inst. of Nuclar Research, Czechoslovak Academy of Science, Rez.). Czech. J. Phys., 17: 917-25(1967). (In Russian).

The isotopic shifts in Er I and Er II spectra were investigated by means of a recording spectrometer with a Fabry-Perot interferometer. The experimental technique of measuring the shifts of the spectral lines consists of using monoisotopic sources of light and a photoelectric record of alternating interference patterns corresponding to the different isotopic components. The values of the relative shifts of 30 lines of erbium and the data of the deformation parameters β of the nuclei of ^{166}Er and ^{162}Er were used for determining the intrinsic quadrupole moment of ^{162}Er. It follows then from the theory of the isotopic effect in the spectra of elements with deformed nuclei, that the value of the intrinsic quadrupole moment is $Q_0(^{162}Er)$ = 7.25 ± 0.30 × 10^{-24} cm^2. (auth)

1676 HINDERED E1 TRANSITIONS IN ^{159}Dy, ^{165}Tm, ^{173}Lu, ^{173}Lu, AND ^{180}W. Conlon, T. W.; Naumann, R. A.; McCarthy, A. L. (Princeton Univ., N. J.). Nucl. Phys., A104: 213-40 (1967).

Several new isomeric states with half-lives in the range 10 μs-30 ms were identified following the 17.5 MeV proton bombardment of the natural elements and separated isotopes of the elements Eu to Pb. The gamma rays from these states were observed using a 8 cm^3 Ge(Li) detector. The E1 isomers observed in ^{159}Dy, ^{165}Tm, ^{173}Lu, ^{180}W, and ^{173}Lu are described. The characteristics of the previously unidentified isomeric states in the first four nuclei, and of some of the intermediate states populated in the decay were measured. The results are discussed in terms of the available states of the single-particle, Nilsson model and its extension to two-particle states and in terms of the selection rules for transitions between these states. A three-particle state is suggested to explain the high-spin isomer observed in ^{159}Dy. (auth)

1677 CONVERSION ELECTRONS AND MULTIPOLARITIES OF TRANSITIONS IN ^{161}Dy. Dutta, B. C.; Egidy, T. v.; Elze, Th. W.; Kaiser, W. (Technische Hochschule, Munich). Z. Phys., 207: 153-85(1967). (In German).

The spectrum of internal conversion electrons emitted by ^{161}Dy after thermal neutron capture was measured with the beta spec-

trometer at the reactor FRM. There were 225 conversion lines found between 0 and 7 MeV. They correspond to 193 transitions. The multipolarities of most transitions were determined. The result of this measurement is in good agreement with the level scheme proposed by Schult et al. Eighteen additional levels with energies up to 3 MeV are proposed. A new $^3/_2^-$-rotational band with its band head at 1103.30 keV is disclosed. The level scheme contains 39% of the complete decay of the capture state. The multipolarities of 6 transitions following the beta decay of ^{165}Dy to ^{165}Ho are given. (auth)

1678 MASS-YIELD DISTRIBUTION OF THE IODINE ISOTOPES FROM THE SPONTANEOUS FISSION OF ^{242}Pu AND THE EXISTENCE OF ^{244}Pu IN THE EARLY SOLAR SYSTEM. Ganapathy, R.; Kuroda, P. K. (Univ. of Arkansas, Fayetteville). Contract AT(40-1)-3235. Earth Planet. Sci. Lett., 3: No. 1, 89-93 (Sept. 1967).

Cumulative fission yields for the mass chains A = 131 to 135 were measured radiochemically by isolating the iodine isotopes resulting from the spontaneous fission of ^{242}Pu with the following results: A = 131, 1.0% (reference standard); 132, 5.0 ± 0.7%; 133, 5.3 ± 0.7%; 134, 6.7 ± 1.0%; 135, 4.9 ± 0.8%. The general pattern of the mass-yield distribution from the ^{242}Pu spontaneous fission is similar to that from the thermal neutron-induced fission of ^{241}Pu, although the relative yields at mass numbers 132 and 134 appear to be slightly higher in the former. The mass-yield distributions of the "excess" heavy xenon isotopes observed in some meteorites show a remarkable resemblance to the shapes of the mass-yield curves from the spontaneous fission of ^{238}U and ^{242}Pu. These results are in agreement with the suggestion that the excess heavy xenon isotopes found in meteorites are the decay products of the "extinct" nuclide ^{244}Pu. (auth)

1679 THE ^{96}Zr(p,p′) AND ^{96}Zr(p,d) REACTION AT 19.4 MeV. Stautberg, M. M.; Johnson, R. R.; Kraushaar, J. J.; Ridley, B. W. (Univ. of Colorado, Boulder). Nucl. Phys., A104: 67-80(1967).

Elastic and inelastic scattering measurements with 19.4 MeV protons from ^{96}Zr were performed. The angular distributions for seven inelastic proton groups were compared to distorted wave calculations using both collective and shell-model form factors. Angular distributions for 11 deuteron groups were measured and compared to distorted wave calculations using a local, zero-range theory. Pick-up of $2d_{5/2}$, $1g_{9/2}$ and $3s_{1/2}$ neutrons was observed and spectroscopic factors determined. (auth)

1680 NUCLEAR TRANSITION STRENGTH SYSTEMATICS IN THE Pb REGION. Alster, J. (Northeastern Univ., Boston). Phys. Lett., 25B: 459-61(Oct. 16, 1967).

Inelastic α-particle scattering from ^{204}Pb and ^{206}Pb was studied. Together with a previous experiment the results show that the transition strengths to the 3^-, 5^-, 2^+ and 4^+ states in ^{208}Pb are unaltered in ^{207}Pb and ^{209}Bi, and the 3^-, 2^+ and 4^+ strengths are unchanged in ^{204}Pb, ^{206}Pb, ^{207}Pb and ^{209}Bi. A comparison is made with other experiments. (auth)

1681 COINCIDENCE SPECTRA OF THE ^{92}Mo(d,np)^{92}Mo REACTION. Moore, C. F. (Univ. of Texas, Austin); Coker, W. R.; Valkovic, V.; Joseph, C.; Sandler, J. Phys. Lett., 25B: 468-9(Oct. 16, 1967). (ORO-2972-36).

Two-parameter spectra taken for deuterons incident on ^{92}Mo exhibit directly the analogue of the $d_{5/2}$ ground state and $s_{1/2}$ first excited state of ^{93}Mo as an intermediate state in the target plus proton system. (auth)

1682 ELASTIC SCATTERING OF 150-MeV ELECTRONS BY $^{116\ 120\ 124}$Sn. Barreau, P.; Bellicard, J. B. (CEN, Saclay, France). Phys. Lett., 25B: 470-2(Oct. 16, 1967). (In French).

Electron elastic scattering on ^{116}Sn, ^{120}Sn, and ^{124}Sn was measured with 150-MeV electrons. This experiment has shown pronounced changes in the charge density of these isotopes. The data analysis is given in terms of phenomenological models. (auth)

1683 COLLECTIVE VIBRATIONS IN EVEN-MASS MERCURY ISOTOPES. Covello, A.; Sartoris, G. (Rutgers, The State Univ., New Brunswick, N. J.). Nucl. Phys., A104: 189-201(1967).

The three even-mass mercury isotopes ^{198}Hg, ^{200}Hg, and ^{202}Hg are described as two proton holes coupled to harmonic surface vibrations. The single-hole states $3s_{1/2}$, $2d_{3/2}$, $1h_{11/2}$ and $2d_{5/2}$, and the core states up to three phonons are included in the model space. The interaction between the two holes is assumed to be a finite-range, spin-dependent force. The energy spectra, the static moments, and the electromagnetic transition probabilities are calculated and compared with experiment. The results are satisfactory, indicating that collective vibrations may indeed play an important role in the description of the mercury isotopes. (auth)

1684 UNIFIED-MODEL CALCULATIONS IN INTERMEDIATE COUPLING WITH $2d_{5/2}$, $1g_{9/2}$, AND $2f_{7/2}$ SINGLE-PARTICLE ORBITS. Heyde, K.; Brussaard, P. J. (Rijksuniversiteit, Utrecht). Nucl. Phys., A104: 81-110(1967).

The energy spectra of the odd-proton nuclides ^{121,125}Sb, ^{129,131}I, ^{143}Pr, and ^{147,149}Pm and of the doubly even nucleides ^{142}Ce, ^{144}Nd, and ^{146}Sm are described in terms of the unified model in intermediate coupling. The phonon energy of the core, the coupling strength between phonon excitations and single-particle motion, the single-particle energies and the strength of the residual interaction between the single particles are all considered as free parameters and are determined in a least-squares fitting procedure. With the wave functions thus obtained, electromagnetic (M1 and E2) moments and transition rates are calculated. Effective g_s factors are determined in a fitting procedure to known magnetic moments; customary effective charges for neutron and proton are used. (auth)

1685 ELECTRON SPECTRA IN THE DECAY OF ^{204}Tl. Park, J. J. H.; Christmas, P. (National Research Council, Ottawa). Can. J. Phys., 45: 2621-38(Aug. 1967).

The continuous beta spectrum and the K Auger-line spectrum in the decay of ^{204}Tl were investigated using a high-resolution, iron-free, $\pi\sqrt{2}$ double-focusing spectrometer. Instrumental distortion of the beta spectrum was shown to be very small and a linear Fermi–Kurie plot was obtained using the generalized unique first-forbidden shape factor $bq^2 + \lambda_2 p^2$, with b = 1.161 ± 0.005. The end-point energy was determined to be 763.24 ± 0.31 keV. Measured values for the energies and relative intensities of the K Auger lines were in broad agreement both with theory and with previous experimental work. The K fluorescence yield was estimated to be 0.97 ± 0.017. (auth) (CANADA)

1686 THE SPIN AND MAGNETIC MOMENT OF ^{138}Cs. Stinson, G. M.; Archer, N. P.; Waddington, J. C.; Summers-Gill, R. G. (McMaster Univ., Hamilton, Ont.). Can. J. Phys., 45: 3393-400(Oct. 1967).

Using source material isolated from the thermal neutron fission of ^{235}U, an atomic-beam investigation of ^{138}Cs was carried out. The results are I = 3 and $|\mu_I|$ = 0.48 ± 0.10 nuclear magnetons. Calculations using a delta-function residual n-p force show that no pure shell-model configuration, appropriate to the mass, is capable of yielding the observed spin. Although the magnetic moment is just consistent with either $(g_{7/2})_3$ or $(g_{7/2})_4$ for the proton configuration and $f_{5/2}$ for the odd neutron, one may conclude that some configuration mixing is involved. The proton part of a plausible wave function is predominantly $(g_{7/2})_3$ with a spin-$^5/_2$ admixture—either $(g_{7/2})_5$ or $(d_{5/2})_3$. In this respect it is similar to the wave function of ^{140}La. (auth) (CANADA)

1687 INTERACTIONS OF 24 AND 27 GeV/c PROTONS WITH COMPLEX NUCLEI IN NUCLEAR EMULSIONS. Rao, G. K.; Rao, P. D. K.; Kamal, A. A. (Osmania Univ., Hyderabad, India). Can. J. Phys., 45: 3211-20(Oct. 1967).

From the analysis of interactions of 24 and 27 GeV/c protons in complex nuclei, the scattered and cascade protons were separated from the integral energy spectrum. An attempt was made to separate interactions in CNO and AgBr statistically by the characteristics of their nuclear recoils. Fair agreement is reached in the frequency of events expected from the composition of the emulsion. The distribution of the number (ν) of target nucleons involved in the central collisions in AgBr is found to follow the Poisson distribution. The ratio of tunnel lengths in AgBr and CNO groups is consistent with the predictions of the tunnel model rather than those of the plural cascade theory. The variation of N_s with ν is also compatible with the tunnel model. (auth) (CANADA)

1688 DECAY OF 9.6d ^{125}Sn TO LEVELS OF ^{125}Sb. Wild, J. F.; Walters, W. B. (Massachusetts Inst. of Tech., Cambridge). Contract AT(30-1)-905. Nucl. Phys., A103: 601-15(1967). (MIT-905-99).

The decay scheme of 9.62 d ^{125}Sn was investigated using NaI(Tl) and Ge(Li) detectors in conjunction with a 4096-channel multiparameter pulse-height analyzer system. Previously unreported γ-rays were observed at 283, 652.6, 1087.4, and 1164.3 keV. Coincidence evidence indicates the presence of a new level at 2253.1 keV as well as a significant γ-ray branching to the $^5/_2^+$ level at 332.0 keV. The β-branching to the ground state was redetermined to be 82.5 ± 5% and new log ft values calculated. The pattern of levels is found to correspond closely with that predicted by the calculations of Kisslinger and Sorensen. (auth)

1689 ACTIVATION CROSS SECTIONS OF Mo ISOTOPES FOR 14.1 MeV NEUTRONS. Cuzzocrea, P. (Univ., Naples. Istituto Nazionale di Fisica Nucleare, Naples); Perillo, E.; Notarrigo, S. Nucl. Phys., A103: 616-24(1967).

Activation cross sections of Mo isotopes were measured with 14.1 MeV neutrons by counting the induced β-activities. The activities of ^{100}Nb were investigated by means of γ- and β-spectra and $\beta-\gamma$ coincidences. (auth)

1690 ON THE PRODUCTION OF THE SUPERHEAVY NUCLEUS ^{310}126. Wong, C. Y. (Oak Ridge National Lab., Tenn.). Contract W-7405-eng-26. Nucl. Phys., A103: 625-43(1967). (ORNL-P-2959).

In order to estimate the formation cross section of the nucleus ^{310}126 by heavy ion bombardments, first the experimental excitation function of the ^{238}U(^{18}O,xn) reaction due to Donets et al. was analyzed in terms of the evaporation model. From what is learned about the neutron evaporation process in this analysis, the cross sections for the reactions ^{231}Pa(^{79}Br,xn), ^{231}Pa(^{81}Br,xn), and ^{251}Cf(^{62}Ni,xn) were estimated. Because the neutron separation energy in these processes is approximately equal to the barrier height for fission of the superheavy compound nuclei around ^{310}126, the equality of the neutron and fission widths was assumed in the calculation. The excitation functions obtained this way showed a peak value of 75 mb at E_{lab} = 439 MeV for the ^{231}Pa(^{81}Br,2n)^{310}126 reaction and of 35 mb at E_{lab} = 353 MeV for the ^{251}Cf(^{62}Ni,3n)^{310}126 reaction. Such cross sections are about 10^4 times larger than the peak value of the cross section for the ^{238}U(^{18}O,5n)^{251}Fm reaction, which gives hope that the formation of ^{310}126 may be experimentally feasible. (auth)

1691 RADIOACTIVE PROPERTIES OF NUCLEI OF VERY HEAVY ELEMENTS. Flerov, G. N.; Druin, V. A. (Joint Inst. for Nuclear Research, Dubna, USSR). pp 249-71 of Struktura Slozhnykh Yader. Bogolyubov, N. N. (ed.). Moscow, Atomizdat, 1966. (In Russian).

The properties of isotopes which can be synthesized in the next few years, were surveyed giving main attention to spontaneous nuclear fission from the fundamental state and also from anomalous excited states. The connection between the half-life for spontaneous fission and the fissionability parameter was discussed, as was the forbiddenness parameter for spontaneous fission of an odd-mass nucleus; and a theoretical interpretation was given of the regularities of spontaneous fission. (JPRS)

1692 CERTAIN PROPERTIES OF ODD DEFORMED NUCLEI IN THE REGION OF RARE EARTH ELEMENTS (SURVEY OF EXPERIMENTAL DATA). Gromov, K. Ya. (Joint Inst. for Nuclear Research, Dubna, USSR). pp 299-324 of Struktura Slozhnykh Yader. Bogolyubov, N. N. (ed.). Moscow, Atomizdat, 1966. (In Russian).

A survey and analysis were made of experimental data published since 1959 on the probabilities of β-transitions in odd deformed nuclei of the rare-earth region and on the collective and three-quasiparticle states of nuclei of that group. (JPRS)

1693 CERTAIN PROBLEMS IN THE STUDY OF SPHERICAL ODD-ODD NUCLEI. Peker, L. K. pp 325-51 of Struktura Slozhnykh Yader. Bogolyubov, N. N. (ed.). Moscow, Atomizdat, 1966. (In Russian).

The study of odd-odd nuclei permits obtaining information about residual p-n interaction otherwise difficult to obtain, but calculations of odd-odd nuclear spectra made so far can be considered to give only qualitative descriptions of peculiarities of multiplet splitting, mainly a description of the sequence of certain lower levels. Nuclear isomerism was discussed, particularly three-quasiparticle and four-quasiparticle isomeric levels, the isomeric state of $^{152}_{63}$Eu with I = 0$^-$, and anomalous isomerism in isotopes of $^{193-201}_{81}$Tl. (JPRS)

1694 INELASTIC SCATTERING OF ALPHA PARTICLES AND DEUTERONS ON ^{185}Re AND ^{187}Re. Bisgard, K. Maack (Univ. of Aarhus, Denmark); Veje, E. Nucl. Phys., A103: 545-64(1967).

Collective states in ^{185}Re and ^{187}Re were studied by inelastic scattering of 16.6 MeV alpha particles and 12.1 MeV deuterons. In both nuclei four members of the ground-state rotational band were observed. In addition, three members of the $K = K_0 - 2$ gamma-vibrational band together with the $K = K_0 + 2$ state were seen. The reduced electric quadrupole transition probabilities for the latter states were determined. The decoupling parameter a for the $K = 1/2^+$ band is 0.39 ± 0.04 (^{185}Re), 0.38 ± 0.04 (^{187}Re) and the inertial parameter $\hbar^2/2I$ is 17.0 ± 0.4 keV (^{185}Re), 18.9 ± 0.4 keV (^{187}Re). The observed angular dependence of the deuteron scattering cross section is discussed. An empirical relationship between the deuteron cross section and the B(E2) value is derived. (auth)

1695 THE $|\Delta K| = 1$, E1 TRANSITIONS IN ODD-MASS ISOTOPES OF Tb AND Eu. Malmskog, S. G. (Aktiebolaget Atomenergi, Studsvik, Sweden); Marelius, A.; Wahlborn, S. Nucl. Phys., A103: 481-95(1967).

Lifetime measurements were performed for the $5/2^-$ [532] intrinsic state in the Tb isotopes with A = 155, 157, 159, and 161. The rates of the $|\Delta K| = 1$, E1 transitions in these isotopes, as well as in ^{153}Eu and ^{155}Eu, are discussed. With the Nilsson model as a starting point, the effects of pairing correlations and Coriolis coupling are calculated. It is found that these effects are not sufficient to account for the essential features of the experimental results. It is suggested that dipole contributions arising through octupole excitations are of importance. (auth)

1696 PROTON SINGLE-PARTICLE STATES ABOVE Z = 82, AS OBSERVED WITH THE REACTION ^{208}Pb(^{3}He,d)^{209}Bi AT $E_{^3He}$ = 51 MeV. Wildenthal, B. H.; Preedom, B. M.; Newman, E.; Cates, M. R. (Oak Ridge National Lab., Tenn.). Phys. Rev. Lett., 19: 960-3(Oct. 23, 1967). (ORNL-P-3447).

The angular distributions of six strong transitions to bound states of ^{209}Bi in the reaction ^{208}Pb(He-3,d)^{209}Bi were measured. An analysis of the data using local non-zero distorted-wave approximations yields a positive identification of the first five of these levels with the $1h_{9/2}$, $2f_{7/2}$, $1i_{13/2}$, $2f_{5/2}$, and $3p_{3/2}$ single-particle states, respectively. (D.C.W.)

1697 OPTICAL-MODEL PARAMETERS AND THE ANALYSIS OF (d,p) STRIPPING EXPERIMENTS ON ^{138}Ba, ^{140}Ce, AND $^{142\ 144\ 146}$Nd. Wiedner, C. A.; Heusler, A.; Solf, J.; Wurm, J. P. (Max-Planck-Institut fuer Kernphysik, Heidelberg). Nucl. Phys., A103: 433-49(1967).

Measurements were made of the (d,p) reactions from ^{138}Ba, ^{140}Ce, ^{142}Nd, ^{144}Nd, and ^{146}Nd to several states in the residual nuclei at a deuteron bombarding energy of 12 MeV. A method is described to extract from (d,d_0), (p,p_0), and (p,n) data, optical-model parameters with errors reflecting the experimental uncertainties. Proton parameters are obtained from optical-model fits of the (p,p_0) excitation functions for ^{138}Ba, ^{140}Ce, ^{144}Sm, ^{142}Nd, ^{144}Nd, and ^{146}Nd in the energy range from 8.6 to 12 MeV at various scattering angles. Smoothly energy and mass dependent proton potentials were obtained with a real potential depth $V = (50 + 0.4\ Z/A^{1/3} + 32.4(N - Z)/A - 0.4E_p) \pm 3.1$[MeV]. The (d,p) data are well reproduced and the spectroscopic factors with uncertainties are extracted using the DWBA. (auth)

1698 THE NEW RADIOISOTOPE ^{99}Ag AND SOME MEASUREMENTS ON ^{100}Ag. Doty, Duane R.; Richardson, J. Reginald; Sunier, Jules W. (Univ. of California, Los Angeles). Contract NONR-233(44). Nucl. Phys., A103: 417-26(1967).

Production of ^{99}Ag with a (p,4n) reaction on ^{102}Pd targets was observed. A half-life of 106 ± 10 sec was measured for gamma transition at 660(30), 750(15), 1040(100), 1525(30), 1700(90), and 3315(35) keV. The growth and decay of the daughter ^{99}Pd was observed. A positron spectrum was resolved into three branches at 3.32(59.2), 2.43(23.9), and 1.69(16.9) MeV. A level scheme is proposed for the levels in ^{99}Pd. A high-energy positon branch at 6.5 ± 0.5 MeV with a 7.5 ± 1 min half-life was observed and is ascribed to ^{100}Ag. The threshold for this production indicates a (p,3n) reaction. In addition, two intense gamma transitions at 556 and 728 keV with the same half-life are ascribed to the decay of ^{100}Ag. (auth)

1699 THE RADIONUCLIDE ^{101}Ag. Doty, Duane R.; Charoenkwan, P.; Sunier, J. W.; Richardson, J. Reginald (Univ. of California, Los Angeles). Contract NONR-233(44). Nucl. Phys., A103: 404-16(1967).

Production of ^{101}Ag with a (p,2n) reaction on ^{102}Pd targets was observed. A half-life of 10.8 ± 0.2 min was measured for the new isotope, and the subsequent growth and decay of its daughter ^{101}Pd was detected. A complex positon spectrum was resolved into energies and intensities of 3.38 MeV (10.0%), 2.73 MeV (43.6%), 2.18 MeV (22.6%), 1.56 MeV (17%), 1.08 MeV (6.2%), and 0.85 MeV (0.6%). Nine gamma transitions from 83 keV to 1164 keV were identified as belonging to the decay of ^{101}Ag. The most intense gamma transition at 263 keV is fed by the high-energy positon branch and establishes the energy available for decay at 4.665 ± 0.08 MeV. A level scheme is proposed with a positive-parity assignment for the first excited energy level in ^{101}Pd. (auth)

1700 LEVELS IN ^{106}Pd FROM DECAY OF 8.5-DAY ^{106m}Ag, 24-MIN ^{106g}Ag, AND 30-SEC ^{106g}Rh. Rao, P. Venugopala; Fink, R. W. (Georgia Inst. of Tech., Atlanta). Contract AT(40-1)-3346. Nucl. Phys., A103: 385-403(1967). (ORO-3346-11).

Gamma spectra from the decay of 8.5 d ^{106m}Ag, 24 min ^{106g}Ag and 30 sec ^{106g}Rh were studied with several sizes of Ge(Li) detectors of high resolution by singles and coincidence methods. Energies and relative gamma intensities of 43 transitions in ^{106m}Ag decay, 13 transitions in ^{106g}Ag decay, and 35 transitions in ^{106g}Rh decay were determined. Using conversion electron intensities from the literature, K-shell conversion coefficients

and multipolarity assignments for many of the transitions in 8.5 d ^{106m}Ag decay were obtained. All except seven transitions are placed in a level scheme of ^{106}Pd consisting of levels at 0, (0^+), 511.6 (2^+), 1127.8 (2^+), 1133.4 (0^+), 1228.9 (4^+), 1557.3 ($3,4^+$), 1561.6 (2^+), 1704.2 (1^+), 1931.9 ($3,4^+$), 2001.2 (0^+), 2040.0 (2^+), 2076.6 ($3,4^+$), 2083.7 (3^-), 2189.3 ($1,2^+$), 2244.4 (2^+), 2305.1 (4^-), 2307.8 ($1^+,2^+$), 2350.3 ($3,4^+$), 2365.0 ($3,4^+$), 2437.3 ($1,2^+$), 2623.0 ($1,2^+$), 2709.0 ($1,2^+$), 2756.3 (5^+), 2826.6 ($1,2^+$), 2918.0 ($1,2^+$), 2950.9 ($5,6^+$), 3042.0 ($1,2^+$), 3057.0 ($1,2^+$) keV. (auth)

1701 LEVELS AND TRANSITION RATES IN ^{199}Au. Backlin, A. (Uppsala Univ. Swedish Research Councils' Lab., Studsvik, Sweden); Fogelberg, B.; Malmskog, S. G. Nucl. Phys., A103: 337-60(1967).

The decay of ^{199}Pt to ^{199}Au ($T_{\frac{1}{2}}$ = 30.8 min) was investigated using a Ge(Li) detector and a double focusing beta spectrometer. 34 transitions were found and multipolarities were assigned for 11 of these, including a 55.15 keV M2 + (0.9 ± 0.5)%E3 isomeric transition. Using these data together with the results of $\gamma-\gamma$ and $\beta-\gamma$ coincidence measurements, a decay scheme containing 9 excited levels and 25 transitions was constructed and spin and parity assignments were made. Using the delayed coincidence technique half-lives were determined for 3 levels and upper limits were obtained for 5 additional levels. The following levels were found: 77.21 ± 0.03 keV ($\frac{1}{2}^+$, 1.1 ± 0.1 ns); 316.98 ± 0.10 ($\frac{5}{2}^+$, <55 ps); 323.57 ± 0.09 keV (($\frac{1}{2}$), $\frac{3}{2}^+$, 35 ± 20 ps); 493.59 ± 0.10 keV ($\frac{7}{2}^+$,<35 ps); 542.82 ± 0.07 keV ($\frac{5}{2}^+$, < 30 ps); 548.65 ± 0.09 keV ($\frac{1}{2}^-$); 734.44 ± 0.11 keV ($\frac{1}{2}^-$, 0.36 ± 0.04 ns); 791.47 ± 0.15 keV ($\frac{3}{2}^+$, $\frac{3}{2}^+$, <50 ps); and 967.98 ± 0.20 keV ($\frac{3}{2}^{(+)}$, $\frac{1}{2}^{(+)}$,<100 ps). The decay properties of the lowest excited positive-parity levels are discussed in terms of de-Shalit's core excitation model. (auth)

1702 MEASUREMENT OF E2/M1 MIXING RATIOS OF $2^+ \rightarrow 2^+$ TRANSITIONS IN ^{82}Kr, ^{106}Pd, ^{122}Te, ^{192}Pt, AND ^{198}Hg. Koch, J.; Muennich, F.; Schoetzig, U. (Institut A fuer Physik, Brunswick). Nucl. Phys., A103: 300-18(1967). (In German).

The E2/M1 mixing ratios of 2^+-2^+ transitions in ^{82}Kr, ^{106}Pd, ^{122}Te, ^{192}Pt, and ^{198}Hg were determined by measuring the angular correlation of the 2-2-0 $\gamma\gamma$ cascades in these nuclei. The following values were obtained: ^{82}Kr (698 keV); $\delta = -1.65 \pm 0.15$, ^{106}Pd (612 keV); $\delta = +4.35 \pm 0.80$, ^{122}Te (686 keV); $\delta = +3.49 \pm 0.07$, ^{192}Pt (296 keV); $\delta = -6.7 \pm 0.5$, ^{198}Hg (675 keV) and $\delta = -1.34 \pm 0.09$. These results are compared with recent theoretical predictions concerning the magnetic properties of even nuclei. (auth)

Nuclear Theory

Refer also to abstracts 1450, 1558, 1562, 1563, 1579, 1594, 1595, 1598, 1600, 1606, 1608, 1613, 1631, 1644, 1648, 1654, 1683, 1684, 1691, and 1693.

1703 (AD-648531) FIVE-DIMENSIONAL QUASISPIN. THE N, T-DEPENDENCE OF SHELL MODEL MATRIX ELEMENTS IN THE SENIORITY SCHEME. Hecht, K. T. (Michigan Univ., Ann Arbor. Dept. of Physics). Feb. 1967. Contract Nonr-1224(59). 97p. CFSTI.

The five-dimensional quasispin formalism is used to factor out the n, T-dependent parts of shell model matrix elements in the seniority scheme and derived reduction formulas which make it possible to express matrix elements for states of definite isospin T in the configuration j exp. n in terms of the corresponding matrix elements for the configuration j exp. v. The n, T-dependent factors for one and two nucleon c.f.p.'s and for the matrix elements of one-body operators and the two-body interaction are expressed in terms of generalized R(5) Wigner coefficients. The needed R(5) Wigner coefficients are calculated in the form of general algebraic expressions for the seniorities v and reduced isospins t corresponding to the simpler R (5) irreducible representations. Explicit expressions are given for the diagonal matrix elements of the general charge independent two-body interaction and the iso-vector and iso-tensor parts of the Coulomb interaction for seniorities v = 0 and 1, and the v = 2 states with n = 4k + 2-2T. (auth) (TAB)

1704 (BMwF-FBK-67-69) BESTIMMUNG EINES ZWEI-NUKLEONEN-SPIN-BAHN-POTENTIALS AUS CLUSTERMODELL-RECHNUNGEN AN LEICHTEN KERNEN. (A Nucleon-Nucleon Spin Orbit Potential from Cluster Model Calculations on Light Nuclei). Wurster, E. J. (Tuebingen Univ. (West Germany). Institut fuer Theoretische Physik). Aug. 1967. 83p. (In German). Dep.

The radial dependence of the nucleon-nucleon spin-orbit potential is assumed to be Gaussian; fitting parameters are the width and depth of the potential well. They are determined to reproduce the experimental elastic α-n phase shifts and the splitting of the ^{7}Li ground state. Using this potential the elastic ^{3}He-^{4}He scattering is investigated; the calculated $\frac{1}{2}^-$ phase shift is in good agreement with the experimental results. Furthermore this spin-orbit potential gives the observed splitting of the ^{3}D-states in ^{6}Li. (auth)

1705 (ISS-67/16) NUCLEAR STRUCTURE DETERMINATION FROM 20 GeV PROTON SCATTERING. Glauber, R. J.; Matthiae, G. (Istituto Superiore di Sanita, Rome (Italy). Laboratori di Fisica). June 29, 1967. 15p. Dep.

Experimental data on the scattering of 20-GeV protons by the nuclei ^{6}Li, ^{7}Li, Be, C, ^{27}Al, Cu, and Pb are analyzed using the multiple diffraction theory of high-energy collisions. Information is obtained on nucleon density, r.m.s. radius, and skin thickness parameters. The information obtained is compared with the results of electron scattering experiments. (S.F.L.)

1706 (ITF-67-14) ELECTRIC QUADRUPOLE MOMENTS OF THE FIRST 2^+ STATES OF EVEN NUCLEI. Davydov, A. S.; Ovcharenko, V. I. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1967. 25p. Dep.

It is shown that the theory of collective excited states of non-spherical even nuclei taking into account the nuclear deformability agrees quantitatively with experimental values of the average electric quadrupole moments for the first 2^+ excited states. (D.C.W.)

1707 (JINR-E4-3445) MATRIX ELEMENTS OF THE HAMADA JOHNSTON POTENTIAL FOR THE HARMONIC OSCILLATOR WAVE FUNCTIONS. Blank, J.; Kuchtina, I. N. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1967. 89p. Dep.

Matrix elements of the regular part of the Hamada-Johnston-potential (outside the hard core) were calculated for the radial functions of a spherical harmonic oscillator for five values of oscillator frequency which are chosen according to the shell-model data of this quantity for nuclei ^{4}He, ^{16}O, and ^{40}Ca. (auth)

1708 (JINR-E4-3453) ONE-PARTICLE STATES OF DEFORMED NONAXIAL NUCLEI. Gareev, F. A.; Vinokurov, L. I.; Kalinkin, B. N. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1967. 22p. Dep.

A method for calculating the one-particle neutron and proton states of nonaxial deformed nuclei is suggested. The average nucleus field is assumed to be described by a finite potential with a diffuse edge. The results may be used for the study of the equilibrium shape of nuclei. (auth)

1709 (JINR-P4-3505) KONFIGURATSIONNOE PREDSTAVLENIE VZAIMODEISTVIYA NUKLONOV PRIVODYASHCHEGO K SVERKHTEKUCHEI MODELI YADRA. (X-Representation of the Nucleon-Nucleon Interaction Used in the Superfluid Nuclear Model). Rybarska, V. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1967. 10p. (In Russian). Dep.

The pairing interaction is investigated in the x-representation. The result is, that this interaction is nonlocal both in the case of pairing in the infinite momentum space and pairing between nucleons of the last unfilled nuclear shell. (auth)

1710 (LA-3751) MODEL-BASED MASS LAW AND A TABLE OF BINDING ENERGIES. Seeger, Philip A.; Perisho Robert C. (Los Alamos Scientific Lab., N. Mex.). Sept. 11, 1967. Contract W-7405-eng-36. 115p. Dep. CFSTI.

A mass law is presented, based on the liquid-drop model with shell and deformation corrections given by the Nilsson model and pairing energy by the Bardeen-Cooper-Schrieffer model. The resulting mass law has 10 parameters, including all model parameters, and gives a standard deviation of 0.78 MeV when adjusted to the binding energies of 1127 known nuclei above mass 40. A table of binding energy, deformation, particle separation energies of protons, neutrons, and alpha particles, and Q-value for electron decay for over 9000 nuclides from Z = 22 to 120 and N = 22 to 200 is given in an appendix. (auth)

1711 SEMICLASSICAL MODEL OF DIRECT REACTIONS. Robertson, I. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). Aust. J. Phys., 20: 489-94 (Oct. 1967).

The semiclassical model of direct reactions is reviewed, and its predictions are presented for a reaction that exhibits the phenomenon of backward peaking, following the work of Pearson. The curve $\sigma(180°)$ against energy is fitted quite closely, and the shape of the curve has a simple explanation in terms of the bound-state radial wave functions. To check the validity of the model, the corresponding distorted-wave Born approximation (DWBA) calculations are carried out; little agreement is found. The semiclassical model severely overestimates the spatial localization in the exact matrix element, and therefore gives cross sections that have a much faster energy variation than the DWBA cross sections. The DWBA calculations can not explain the experimental results on backward peak-

ing, and it is concluded that the agreement between the semiclassical model and experiment is fortuitous. (auth)

1712 NUCLEAR LEVEL DENSITIES IN INTERMEDIATE AND HEAVY NUCLEI. Cook, J. L.; Ferguson, H.; Musgrove, A. R. deL. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). Aust. J. Phys., 20: 477-87 (Oct. 1967).

The level densities of intermediate and heavy nuclei were fitted to the free gas model formula with some improvement over previous fits. The predictions of the model regarding cross section behavior have been tested and found to lead to anomalous behavior of the partial widths for incident neutron energies above 1.5 MeV (auth)

1713 ELEMENTS OF THE BRUECKNER-GOLDSTONE THEORY OF NUCLEAR MATTER. Day, B. D. (Argonne National Lab., Ill.). Rev. Mod. Phys., 39: 719-44(Oct. 1967).

The basic ideas of the Brueckner–Goldstone theory of nuclear matter are presented in a simple way. The treatment is aimed at beginners and nonspecialists. It is supposed to provide the necessary background for the review article by Bethe and Rajaraman which follows this paper. Therefore, the discussion is limited to a few important topics, and these are considered in some detail. The Goldstone expansion is presented (but not derived) and the construction and evaluation of the Goldstone diagrams are explained. The reaction matrix and the correlated two-body wave function are defined, and their properties are discussed. The reference-spectrum method for calculating the reaction matrix is derived, and its use is illustrated. Finally, the related topics of convergence and the definition of single-particle energies are considered. The choice of the single-particle potential energy for occupied states is treated in detail. (Intermediate-state energies will be discussed by Bethe and Rajaraman.) The reason for the divergence of the perturbation series for the binding energy is exhibited; and this series is rearranged into a convergent expansion, for which the density plays the role of small parameter. (auth)

1714 THREE-BODY PROBLEM IN NUCLEAR MATTER. Rajaraman, R. (Univ. of Southern California, Los Angeles); Bethe, H. A. Contract AT(04-3)-136. Rev. Mod. Phys., 39: 745-70(Oct. 1967). (USC-136-115; TID-23736).

Some recent developments in the theory of nuclear matter are reviewed. Assuming familiarity with the basic Brueckner–Goldstone theory, it is first shown that the Brueckner–Goldstone series does not converge in powers of the reaction matrix and that the perturbation series for the binding energy has to be rearranged in powers of the density ρ. Physical reasons and actual estimates are provided for expecting convergence in powers of ρ. A detailed theory is outlined for the evaluation of the three-body energy, which gives the ρ^2 term. Attention is paid to both the momentum dependence of the reaction matrix and the tensor nature of nuclear forces. Finally, the last section is devoted to the choice of the single-particle potential energies, suitably designed so as to absorb most of the four-body and higher cluster terms. (auth)

1715 FORM OF THE IMAGINARY PART OF THE OPTICAL POTENTIAL. Gross, Dieter (Technische Hochschule, Munich). Z. Phys., 207: 251-67(1967).

The imaginary part of the optical potential ImV(r) is derived from Migdal's theory of nuclear structure. It is shown that the strong enhancement of ImV(r) at the nuclear surface is mainly due to a suppression of the effective nucleon-nucleon force by collective effects in the nuclear interior. (auth)

1716 DOPPLER-SHIFT ATTENUATION CALCULATIONS FOR LOW RECOIL VELOCITIES. Broude, C. (Chalk River Nuclear Labs., Ont.). Can. J. Phys., 45: 3415-19(Oct. 1967). (AECL-2938).

Attenuation factors and detailed line shapes were calculated on the basis of theoretical stopping cross sections using a program written for a G-20 computer. The results of some calculations for the reaction $^{25}Mg(\alpha,n\gamma)^{28}Si$ are presented. (D.C.W.)

1717 MAGNETIC MOMENTS OF NUCLEI WITH CLOSED j–j SHELLS PLUS OR MINUS ONE NUCLEON. Mavromatis, H. A. (Univ. of Sussex, Eng.); Zamick, L. Nucl. Phys., A104: 17-34(1967).

The correction to the Schmidt moment of ^{209}Bi calculated with the Hamada-Johnston potential is shown to be 0.8 n.m. to first order in perturbation theory. This improvement on the zero-order Schmidt moment is compared with previous, smaller first-order corrections calculated with other potentials. A discrepancy with experiment of 0.66 n.m. still remains for this nucleus if one stops at first-order perturbation theory. Complete second-order calculations for ^{29}Si and ^{209}Bi are performed which worsen agreement between theory and experiment. The second-order correction for ^{209}Bi is −0.21 n.m. and for ^{29}Si −0.06 n.m. (compared with a +0.73 n.m. first-order correction for the latter nucleus). Certain Tamm-Dancoff and RPA type diagrams which turn out to be important in the second-order calculations are summed to all orders. Our second-order calculations are performed with the Kallio-Kollveit potential. (auth)

1718 SEPARATION OF DIRECT AND COMPOUND EFFECTS BY POLARIZATION MEASUREMENTS. Thompson, W. J. (Florida State Univ., Tallahassee). Phys. Lett., 25B: 454-5(Oct. 16, 1967).

The vector polarization of nuclear reaction products depends only on direct-interaction effects if the compound-nucleus scattering amplitudes have random phase. This result can be used to separate the direct and compound effects. The application to nucleon elastic scattering is outlined. (auth)

1719 ON THE POSSIBILITY OF GAPLESS SUPERCONDUCTIVITY IN DEFORMED NUCLEI DUE TO THE CORIOLIS INTERACTION. Goswami, A. (Case Western Reserve Univ., Cleveland); Lin, L.; Struble, G. L. Contract AT(11-1)-34. Phys. Lett., 25B: 451-4(Oct. 16, 1967).

It is shown that the energy gap for the excitation of quasiparticles in the presence of the Coriolis force can vanish for some values of angular momentum even if the order parameter Δ is not zero. (auth)

1720 SUM RULE FOR RESONANCE REACTIONS. Moldauer, P. A. (Argonne National Lab., Ill.). Phys. Rev. Lett., 19: 1047-8(Oct. 30, 1967).

It is shown that in the absence of direct reactions, the averages of the diagonal elements of the pole-residue matrices $-iG_\mu$ of the S matrix (sometimes called partial widths) satisfy $2\pi\langle G_{\mu cc}\rangle_\mu/D = \exp(2i\xi_c)T_c/(1-T_c)^{1/2}$, where D is the average pole spacing, T_c is the optical-model transmission coefficient, and ξ_c is the real part of the optical-model phase shift. (auth)

1721 POTENTIAL RESTORATION BY NUCLEAR-COULOMB SCATTERING PHASES. Mentkovskii, Yu. L. (Inst. of Physics, Kiev). Ukr. Fiz. Zh., 12: 1437-41(Sept. 1967). (In Russian).

A theory of the restoration of a spherically symmetric cutoff nuclear potential $v(r)$ by scattering phases $\delta(k)$ of charged particles is presented. A total potential is supposed to be given by the formula: $V(r) = a/r + v(r)$, where $a > 0$ $\int_0^\infty dr\, r|v(r)| < \infty$. The assumption of the potential spherical symmetry is not essential here and is involved only for the sake of simplicity, while the cutoff character of its nuclear part is of great importance. (auth)

1722 LINKED-CLUSTER EXPANSIONS FOR THE NUCLEAR MANY-BODY PROBLEM. Brandow, Baird H. (Univ. of Copenhagen, Cornell Univ., Ithaca, N. Y.). Rev. Mod. Phys., 39: 771-829(Oct. 1967).

The Goldstone expansion is rederived by elementary time-independent methods, starting from Brillouin–Wigner (BW) perturbation theory. Interaction energy terms ΔE are expanded out of the BW energy denominators, and the series is then rearranged to obtain the linked-cluster result. Similar algebraic methods lead to the linked expansions for the total wave function (Hugenholtz) and the expectation value of a general operator (Thouless). Starting again with a degenerate version of BW perturbation theory, these methods are used to obtain the Bloch–Horowitz energy expansion, as well as the corresponding wave function, expectation-value, and transition-amplitude expansions. A "reduced" form of the Block–Horowitz expansion is described, and also a "completely linked" version. The latter is suggested as a tool for investigating superfluid phenomena in nuclear matter, and for establishing contact with the Landau theory of Fermi liquids. The physical interpretation of these expansions is carefully studied, especially with regard to nuclear applications, to determine how they handle such "physical" features as antisymmetry, self-energy effects, wave-function renormalizations, and the distinction between "true" and "model" single-particle occupation probabilities. The problem of a correct theoretical definition for the shell-model potential is carefully examined, and a specific theory is presented. These expansions are seen to form a convenient and very powerful set of tools for studying the structure of actual nuclei. (auth)

1723 TRANSITION DENSITIES OF DIPOLE EXCITATIONS IN NUCLEI WITH N > Z. Goulard, B. (Univ. Laval, Quebec); Faillieros, S. Can. J. Phys., 45: 3221-34(Oct. 1967). (NYO-3525-23).

The transition charge densities characterizing the excitation

of nuclear dipole states are discussed. The splitting of the dipole strength into two components of different isospin is emphasized. The results are illustrated for the specific case of the nucleus ^{90}Zr. (auth) (CANADA)

1724 WAVE FUNCTIONS FOR MIXED CONFIGURATIONS AND THE RACAH ALGEBRA OF SU(4). Kukulin, V. I. (Moscow State Univ.); Smirnov, Yu. F.; Majling, L. Nucl. Phys., A103: 681-91(1967).

A new method of construction of many-nucleon wave functions with a given Young tableau for two unfilled shells is described. The Racah algebra of the group SU(4) is employed for obtaining the many-particle coefficients of fractional parentage as well as calculations of matrix elements of one- and two-particle operators. (auth)

1725 COLLECTIVE MONOPOLE VIBRATIONS IN CLOSED-SHELL NUCLEI. Blomqvist, J. (Research Inst. for Physics, Stockholm. Royal Inst. of Tech., Stockholm). Nucl. Phys., A103: 644-56(1967).

A one-particle-one-hole, shell-model calculation of the $J^\pi = 0^+$, T = 0 breathing modes in the closed-shell nuclei ^4He, ^{16}O, ^{40}Ca, and ^{208}Pb was performed in the framework of the random phase approximation. With empirical single-particle energies and an effective interaction similar to the G-matrix derived by Brown and Kuo, the RPA solutions break down for ^{40}Ca and ^{208}Pb. This is interpreted as evidence for strong renormalization effects through the coupling to collective shape oscillations. Solutions are obtained with a modified interaction and transition probabilities and form factors are presented. (auth)

1726 ANTISYMMETRY IN DISTORTED-WAVE CALCULATIONS OF INELASTIC NUCLEON SCATTERING. Amos, K. A. (Univ. of Pittsburgh). Nucl. Phys., A103: 657-76(1967).

Distorted-wave calculations of the inelastic scattering of 18.9 MeV protons to the first excited state of ^{89}Y were performed using bound-state wave functions consistent with spectroscopic information and using projectile wave functions generated from a seven-parameter optical-model potential that is determined by elastic scattering. Exchange terms appear in the calculations because the initial-state wave function is antisymmetrized and because the two-nucleon effective interaction has an exchange character. The effective interaction is taken to have a central static form, that is a linear combination of three Yukawa functions. Two dissimilar parametrizations of this interaction are considered, each of which is determined from aspects of free two-nucleon scattering. Comparison with limited experimental data encourages belief that these "no-parameter" microscopic distorted wave calculations are credible and that this reaction should help to calibrate the matrix elements needed to analyze more complicated reactions. (auth)

1727 THREE-BODY APPROACH TO DIRECT NUCLEAR REACTIONS. Shanley, P. E. (Univ. of California, Davis); Aaron, R. Ann. Phys. (N.Y.), 44: 363-425(1967). (UCD-CNL-73).

Recently developed methods of treating the three-body problem are applied to nuclear rearrangement collisions involving a neutron, a proton, and a heavy nucleus assumed to have no internal structure. The two-body interactions are parameterized in terms of s-wave separable potentials and the resulting three-body equations are solved exactly on a high-speed computer. Results are obtained for a spinless model which neglects the proton-core interaction and these are compared with the general behavior of experimental results although no attempt is made to fit a particular nucleus. These exact results are also used as a test of the distorted-wave Born approximation and of some high energy diffraction models. The theory is then generalized to include spin, isospin, and a charge independent nucleon-core interaction parameterized with the core assumed to be ^{16}O. Numerical results are obtained for this system which resemble some general features of the experimental situation but detailed agreement is not obtained. Finally, further generalizations of the model are discussed and the possibility of applying three-body methods to other nuclear systems is considered. (auth)

1728 SEPARABLE NON-LOCAL TWO-NUCLEON POTENTIAL FOR ODD-PARITY SPIN TRIPLET STATES. Naqvi, J. H. (International Atomic Energy Agency, Trieste, Italy). Nucl. Phys., A103: 565-76(1967).

A separable non-local two-nucleon potential for spin triplet odd-parity states is presented which reproduces the YLAM phase parameters up to about 320 MeV. The potential is taken to be effective in l = 1, 3, and 5 states only and essentially consists of L-dependent central, tensor, linear, and quadratic spin-orbit parts. (auth)

1729 GENERALIZED OPTICAL MODEL FOR ELASTIC AND QUASI-ELASTIC SCATTERING OF PROTONS. Mueller, Kh. (Central Inst. for Nuclear Research, Rossendorf, Ger.). Nucl. Phys., A103: 513-24(1967).

The isospin dependence of the nuclear optical potential is studied using projection formalism. Exchange effects are taken into account. Instead of Lane's phenomenological potential $V_0 + V_1 t \cdot T$, a potential $V_0 + V_1(2t_3T_3 - t \cdot T)$ is found. The difference leads to a change of the relative sign between the wave functions p and n, describing the motion of the proton and a neutron, respectively. An explicit relation between the functions p,n and the full wave function is given. General expressions for the potentials V_0 and V_1 are derived. They may serve as a starting point for microscopic theory. (auth)

1730 A SYMMETRY IN THE EFFECTIVE INTERACTION OF KUO AND BROWN. Parikh, J. C. (Univ. of Copenhagen); Bhatt, K. H. Nucl. Phys., A103: 496-502(1967).

The effective residual interaction of Kuo and Brown is analyzed for its symmetries. It is shown that their matrix elements have essentially Majorana exchange character. Further it is seen that the lowest states in ^{18}O and ^{18}F can be generated from a simple axially symmetric intrinsic state, and such an intrinsic state is shown to result from a Hartree–Fock calculation. (auth)

1731 IMPROVED SOLUTION OF THE CRANKING MODEL THROUGH PROJECTIONS. Lehmann, G. (Technical Univ., Dresden). Ann. Phys. (Leipzig), 20: 29-44(1967). (In German).

The description of rotational states of deformed nuclei by the cranking model yields an energy spectrum $E = \omega^2\Theta/2$ which is continuous in angular velocity ω. Another approach given by Peierls and Yoccoz for description of rotational states projects out of the wave function of the deformed nucleus eigenfunctions of angular momentum. The errors of this method are discussed and removed using the solution of the cranking model ("pushing" model) in the case of translation. In the case of rotation in three dimensions this improved approach leads to a discrete spectrum of the form $E = (\hbar^2/2\Theta_c)\, L(L+1)$ with the moment of inertia Θ_c following from the self-consistent cranking model. Also one gets preferred angular velocities. (auth)

1732 BLOCKING EFFECTS IN THE ASYMMETRIC ROTOR MODEL. Davidson, M. G.; (Australian National Univ., Canberra). Nucl. Phys., A103: 427-32(1967).

The inability of the asymmetric rotor model to accurately describe the positive-parity level spacing of β-vibration bands in deformed even nuclei is discussed, and the introduction of blocking effects is considered. It is found that including the blocking effects improves the model predictions for both β-vibration and ground-state bands and reduces the average fitting error by roughly a factor of $\frac{1}{3}$. (auth)

1733 THE REACTION $d + {}^3He \rightarrow {}^3H + (pp)$. Henley, E. M. (Univ. of Washington, Seattle); Richards, F. C.; Yu, D. U. L. Contract AT(45-1)-1388. Nucl. Phys., A103: 361-84(1967). (RLO-1388-515).

The reaction $d + {}^3He \rightarrow {}^3H + 2p$ is studied in the region of phase space where the (pp) final-state interaction is important, that is for the most energetic ^3H nuclei. Two reaction processes are considered in detail, a pick-up mechanism and a charge-exchange reaction. The cross section is computed by three methods; a modified Born approximation, comparison with the elastic scattering $d + {}^3He$, and a distorted wave approximation. The dependence of the calculated differential cross section on the form of the interaction is studied, and results are compared with experiment. (auth)

1734 PHENOMENOLOGICAL TEST OF THE INDEPENDENT QUASI-PARTICLE MODEL. Gillet, Vincent; Giraud, Bertrand; Rho, Mannque (Centre d'Etudes Nucleaires de Saclay, Gif-sur-Yvette, France). Nucl. Phys., A103: 257-99(1967).

The analysis of the experimental low-lying spectra of single-closed-shell nuclei by means of the inverse gap equations method yields uniquely in the pairing model the effective nucleon–nucleon force strength, the Hartree–Fock single-particle energies and the BCS wave functions. The results are free from any adjustable parameter. The constancy in a given nuclear region of the force strength and of the HF energies thus provides an unambiguous test of the pure one-quasi particle description for such nuclei. The analysis is carried out with a central, finite-range force for all spherical single-closed shell nuclei for which enough data are available (i.e., the isotones N = 28 and 50, and the isotopes Z = 28, 50, and 82). The results show the importance of including more than one major shell for the pairing effects. Inclusion of remote shells renormalizes the force strength appreciably. However, it does not affect the wave functions of quasi particle

states near the Fermi level. When the number of nucleons is varied, the extracted force strength and the Hartree–Fock energies remain nearly constant (within ±1 MeV and ±0.5 MeV, respectively), which is close to their average value in most of the studied nuclear regions. (auth)

1735 ON STATISTICAL REACTIONS IN FISSIONING NUCLEI. FISSION ISOMERS POPULATED IN xnγ REACTIONS. Jagare, S. (NORDITA, Copenhagen). Nucl. Phys., A103: 241-56(1967).

A spin-dependent statistical treatment of (b,xnγ) reactions in fissioning nuclei is given. The spin dependence of the probability for fission is discussed, and the model is applied to some reactions which populate the spontaneously fissioning isomeric states in ^{240}Am and ^{242}Am. The determination of the spins of these isomers is discussed. (auth)

1736 SYSTEMATICS OF THE FULL β DECAY HALF-LIVES. Kolesnikov, N. N.; Krylova, A. P. Vestn. Moskov. Univ., Ser. III: Fiz. Astron., 21: No. 2, 113-16(Mar.–Apr. 1966). (In Russian).

The logarithm of the full β decay and electron capture half-lives τ, including transitions to all permissible energy levels of the final nucleus, of heavy nuclei with Z > 86, decrease linearly with increasing values of the logarithm of the expression $|Z - Z_{\beta^-}| - 1$, whereby Z_{β^-} designates the Z of a fictional isobar located at the boundary of the β^- stability. This law applies to all, not too light, β^- and β^+ active, A > 90 nuclei, the $|Z - Z_{rp}|$ value of which is not too small. In this case, Z_{rp} designates the Z of a fictional nucleus at the boundary of the possible β^- or β^+ decay. In this connection, the full β^- or β^+ decay of more than 250 nuclei with A > 90 was investigated, comparing previously reported experimental data with values derived from an expression defining log τ. Nuclei, the β decay of which traverses the magic numbers N = 50, 82, and 126 and those with N = 88 to 90, for which no Z_{pr} numbers were available, were not included in the study. The results could be explained by assuming that at high β^- decay energies, transitions to the permissible levels of the final nucleus become possible if transition to the ground state was forbidden. These transitions affect strongly the full β-decay half-life, if the ratio of their energies to the difference of the ground-state energies does not differ markedly from 1. The considerations support the above-stated linear correlation. (TTT)

1737 INVESTIGATION OF NUCLEAR EFFECTS IN BREMSSTRAHLUNG. Acker, H. L.; Rose, M. E. (Univ. of Virginia, Charlottesville). Ann. Phys. (N.Y.), 44: 336-62(1967). (ORO-2915-64).

A generalization of the usual inelastic electron scattering, proposed by Hubbard and Rose, is discussed where, in addition to the scattered electron, the photon is detected in coincidence. This photon is either due to bremsstrahlung or to electroexcitation and subsequent γ-decay of a nuclear level. The interference between both processes is studied in detail. Numerical results are given for the giant resonance region of ^{16}O and two levels in ^{12}C (4.43 and 15.11 MeV). The coincidence experiment seems to be a very useful tool in determining spins and parities of nuclear levels. In contrast to the usual inelastic electron scattering, in this spin analysis, no model concerned with the dependence of the nuclear form factors on momentum transfer enters. The interference phenomena between electron bremsstrahlung and nuclear radiation turn out to be quite noticeable in the differential cross section for coincidence experiments. The interference terms are less important in the cross section integrated over photon angles which corresponds to the usual inelastic electron-scattering experiments. (auth)

1738 DECAY BY BETA PARTICLES. Janouch, Frantisek; Vinduska, Milan (Inst. of Nuclear Research, Czechoslovak Academy of Sciences, Rez). Cesk. Cas. Fys., 17: 287-302(1967).

The theory of beta radioactivity is discussed. The approximations used in the theory of beta nuclear decay are reviewed, and an analysis of experiments by which the form of decay of the Hamiltonian and the constants contained in it is presented. Nuclear matrix elements, the influence of an electric field of the nucleus and of the atom on beta decomposition, and new theories in the theory of weak interactions related to beta decay are discussed. (JPRS)

1739 STRUKTURA SLOZHNYKH YADER. LETNYAYA SHKOLA FIZIKOV. (Structure of Complex Nuclei. Summer School for Specialists in Physics). Bogolyubov, N. N. (ed.). Moscow, Atomizdat, 1966. 352p.

Separate abstracts were prepared for 11 papers dealing with nuclear structure and nuclear theory. (D.C.W.)

For abstracts of individual papers see: 1691–1693 and 1740–1747.

1740 NUCLEAR THEORY. Ulegla, I. M. (Joint Inst. for Nuclear Research, Dubna, USSR). pp 5-37 of Struktura Slozhnykh Yader. Bogolyubov, N. N. (ed.). Moscow, Atomizdat, 1966. (In Russian).

A survey was made of status of nuclear theory; its principal hypotheses and their inadequacies were considered. Perturbation theory was examined, and the applications of nuclear theory for examination of the properties of nuclear matter and relatively light nuclei, two extreme cases, were discussed in detail as presenting a relatively simple verification of the theory. (JPRS)

1741 PAIR CORRELATIONS AND THE STRUCTURE OF DEFORMED NUCLEI. Solov'ev, V. G. (Joint Inst. for Nuclear Research, Dubna, USSR). pp 38-86 of Struktura Slozhnykh Yader. Bogolyubov, N. N. (ed.). Moscow, Atomizdat, 1966. (In Russian).

The principal postulates of the superfluid model of the nucleus are presented. Although it is a fairly rough model, calculations made with it agree well with experimental data. The principal properties of quadrupole and octupole states are described fairly well, but the accuracy with which many characteristics of the nucleus are calculated is limited mainly by the roughness of the description of the average field. (JPRS)

1742 QUASI-PARTICLES METHOD IN NUCLEAR THEORY. Migdal, A. B. pp 87-110 of Struktura Slozhnykh Yader. Bogolyubov, N. N. (ed.). Moscow, Atomizdat, 1966. (In Russian).

The approach to nuclear theory in which the nucleus is regarded as a gas consisting of two types of interacting quasiparticles placed in a potential well is reviewed. The effective interaction between the neutron and proton quasiparticles and the behavior of a particle in an external field of a gas of such interacting quasiparticles is determined by a Green's function method using a Feynman diagram technique. Equations in diagram form are given for the effective field and the effective interaction of quasiparticles in an unfilled shell for nuclei in an external field, for magnetic and quadrupole moments and for the isotopic shift, and for electromagnetic and beta-decay transitions (dipole excitations, quadrupole transitions, 1-forbidden transitions, and μ decay). The theory developed makes it possible to replace the model solutions of nuclear structure problems by rigorous solutions using universal constants of the theory. (ATD)

1743 CALCULATIONS FOR LIGHT NUCLEI BY THE METHOD OF THE SELF-CONSISTENT FIELD. Brink, D. M. pp 111-34 of Struktura Slozhnykh Yader. Bogolyubov, N. N. (ed.). Moscow, Atomizdat, 1966. (In Russian).

It was pointed out that, when the Hartree-Fock method is used to find an approximate solution of the many-body problem of quantum mechanics, states often are obtained which are not eigenstates of preserved values, e.g., angular momentum and parity. The method of deformed orbits for constructing deformed internal states for eigenstates of those values was described, and the results obtained by various authors were discussed. It was pointed out that the method uses fairly considerable approximations. (JPRS)

1744 GROUP THEORY METHODS IN NUCLEAR PHYSICS. Flach, G. pp 135-57 of Struktura Slozhnykh Yader. Bogolyubov, N. N. (ed.). Moscow, Atomizdat, 1966. (In Russian).

The principles of group theory and problems of classification of states in a shell model were discussed. The interaction energy of a single shell and the construction of wave functions were discussed; and solutions of those problems were presented, as well as results given by the theory for light nuclei. It was explained that, in nuclear theory, algebraic methods are limited to the use of a shell model because it uses as its basic system functions which are rather degenerate even when the interactions between the nucleons are very indeterminate. Although a shell model, or at least the conditions to which one is limited from certain considerations, is too rough, it was concluded that it does permit explaining certain general regularities of light nuclei. (JPRS)

1745 INVESTIGATION OF THE STRUCTURE OF THE NUCLEUS BY MEANS OF REACTIONS CAUSED BY ^{3}H NUCLEI. Nathan, O. pp 158-88 of Struktura Slozhnykh Yader. Bogolyubov, N. N. (ed.). Moscow, Atomizdat, 1966. (In Russian).

An elementary survey of a generalized model of the nucleus was presented with a discussion of important trends in nuclear spectra; an examination of some main points of a scheme with paired coupling, an ordered scheme of coupling, and competition between those schemes; and principal results of the introduction of orbital motion. After a discussion of certain main features of the orbital motion of nuclei, nuclear moments of inertia were examined on the basis of a coupling model, and the vibrations of spherical nuclei were discussed. (JPRS)

1746 DEFORMED NUCLEAR STATES. Dzhelepov, B. S. pp 189-200 of Struktura Slozhnykh Yader. Bogolyubov, N. N. (ed.). Moscow, Atomizdat, 1966. (In Russian).

A discussion was presented of the directions in which the number of deformed nuclear states can be expanded: new regions of deformed nuclei, boundary regions, individual islets or individual nuclei, different states of a single nucleus, and mixed circular + noncircular states. Criteria of deformation were then defined, and values of the deformation parameter β were presented. (JPRS)

1747 MAGNETIC PROPERTIES OF STRONGLY DEFORMED ATOMIC NUCLEI. Hrynkiewicz, A. A.; Ogaza, S. pp 272-98 of Struktura Slozhnykh Yader. Bogolyubov, N. N. (ed.). Moscow, Atomizdat, 1966. (In Russian).

The magnetic dipole moment of the nucleus and the reduced probabilities of magnetic dipole transitions were discussed, and experimental methods of determining the magnetic properties of nuclei were surveyed. Experimental data were then compared with the theoretical description of the magnetic properties of strongly deformed nuclei for nuclei with $150 < A < 190$. (JPRS)

1748 STRUCTURE OF THE ATOMIC NUCLEUS. Kvasnica, Josef. London, Iliffe Books, Ltd., 1967. 121p.

The basic concepts of the quantum theory and the theory of relativity are outlined. The basic properties of nuclei are then discussed, as are nuclear forces, nuclear models, and nuclear decay. (D.C.W.)

REACTOR TECHNOLOGY

Central Power Reactors

Refer also to abstracts 119, 206, 267, 619, 627, 646, 720, 1001, 1578, and 1915.

1749 (AD-648248) REMOVAL OF OXYGEN FROM SODIUM. McKee, J. M. (United Nuclear Corp., Elmsford, N. Y. Research and Engineering Center). Apr. 1966. Contract AF33(615)-2338. 63p. (UNC-5143; AFAPL-TR-66-27). CFSTI.

Anodic electrolysis of oxide-coated gettering alloys in Na was evaluated as means of increasing their O_2 removal rate. Twenty-two Zr and Th base alloys were tested in Na thermal convection loops. Detectable increases in gettering rate were observed for unalloyed Zr and a few other alloys which formed adherent, dense, black films. The gains were not large enough to warrant practical application, apparently due to electronic short circuiting through small film defects. Some of the alloys which formed nonadherent, porous white films achieved higher removal rates than had been hoped for from electrolysis. Zr-13 a/o Ti was the best of these. This alloy produced an O_2 content of less than 1 ppM in Na and maintained significantly higher removal rates than pure Zr at all temperatures and O_2 levels. (auth)

1750 (APDA-206) QUARTERLY TECHNICAL PROGRESS REPORT ON AEC-SPONSORED ACTIVITIES, MARCH 15-JUNE 15, 1967. (Atomic Power Development Associates, Inc., Detroit, Mich.). Contract AT(11-1)-865. 113p. Dep. CFSTI.

Progress is reported for projects including: Na-water reaction studies; H_2 behavior in the Na technology loop; A-scan and C-scan tests with narrow-beam ultrasonic transducers in Na at 600°F; and equations of state of UC and U alloy. (D.C.C.)

1751 (APDA-CFE-13) COMPILATION OF CURRENT TECHNICAL EXPERIENCE AT ENRICO FERMI ATOMIC POWER PLANT. Monthly Report No. 13, August 1967. McCarthy, J. F. (Atomic Power Development Associates, Inc., Detroit, Mich. Power Reactor Development Co., Detroit, Mich. Detroit Edison Co., Mich.). Oct. 1967. Contract AT(11-1)-865. 26p. Dep. CFSTI.

Relocation of Fermi Fast Breeder fuel subassemblies in the reactor lattice to allow viewing of the hold down fingers is detailed. Draining of the sodium coolant from the reactor vessel is discussed. Reactor vessel inspection is described. Results of core section subassembly M127 analysis at the Battelle Memorial Institute hot cells are shown. (M.L.S.)

1752 (APDA-NTS-11) OSCILLATOR TESTS IN THE ENRICO FERMI REACTOR. Klickman, A. E.; Horne, R. E.; Wilber, H. A. (Atomic Power Development Associates, Inc., Detroit, Mich.). Aug. 1967. 145p.

The requirement of two oscillator rods was anticipated for making oscillator tests in the Enrico Fermi reactor—one rod for low power and the other for higher power. Prior to the tests, the oscillator rods were installed in the core and their worths were measured. The gross worth and amplitude of both rods agreed reasonably well with the predicted values. The zero-power transfer function was measured by means of oscillator tests, using four measurement techniques. The most satisfactory of these from the standpoint of frequency capability, completeness of information and ease of making measurements, was the method which employed the synchronous transfer function analyzer. The reactor transfer function was measured at powers up to 111 MW(t) with the reactor in both manual and automatic control. The reactor stability was investigated, using the results of the oscillator tests, and it was stable under both modes of control. A simple amplitude criterion was used for the cases with the reactor in manual control and the Nyquist criterion was used for the cases with the reactor in automatic control. The feedback transfer function was extracted from the reactor transfer function data obtained at 67 MW(t) and 11 MW(t). The feedback contained a substantial component with a long time constant (several seconds), which was not anticipated. The transfer function of the automatic control system was also extracted and analyzed. (auth)

1753 (BMI-1815) AN EVALUATION OF THE APPLICABILITY OF EXISTING DATA TO THE ANALYTICAL DESCRIPTION OF A NUCLEAR-REACTOR ACCIDENT. Quarterly Progress report, July-September 1967. Morrison, David L.; Carbiener, Wayne A.; Ritzman, Robert L.; (and others) (Battelle Memorial Inst., Columbus, Ohio). Oct. 1, 1967. Contract W-7405-eng-92. 30p. Dep. CFSTI.

Modifications to the boil-off and radiation models in NURLOC-1.0 are discussed. An evaluation of the sensitivity of NURLOC-1.0 calculations is made. Heat transfer coefficient calculations for a typical BWR during blowdown are given; fuel rod surface temperature for a typical BWR during blowdown is given. Results of calculations for PWR fuel element cladding stresses are shown. Time-dependent fission product transport and deposition calculations are tabulated. Fission product behavior studies in containment vessels is discussed. 15 references. (M.L.S.)

1754 (BNL-11610) TRANSPORT OF FISSION-PRODUCT IODINE FROM MOLTEN URANIUM. Tang, I. N.; Castleman, A. W. Jr. (Brookhaven National Lab., Upton, N. Y.). 1967. 3p. (CONF-671102-21). Dep. CFSTI.

From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill.

The transport of volatile fission products in condensed and gas phases is discussed. The rate of transport across the vapor-liquid interface was expressed by the Langmuir equation for vaporization, generalized for nonideal multicomponent solutions. The experimental results on the release of fission product ^{131}I from molten uranium is presented with the emphasis on the elucidation of the release mechanism. (D.C.C.)

1755 (BNWL-SA-1326) HIGH EXPOSURE PLUTONIUM STUDIES RADIATION HAZARDS AND POWER REACTOR NUCLIDE CONTENT. Smith, R. C.; Faust, L. G. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Aug. 16, 1967. Contract AT(45-1)-1830. 13p. (CONF-671102-29). Dep. CFSTI.

From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill.

The buildup of ^{241}Pu daughter products, ^{241}Am, and ^{237}U, contribute significantly to the surface dose rate of high exposure Pu. Data show that within one year after chemical separations ^{241}Am contributes up to 50 percent of the total γ dose rate for most high exposure Pu containing three percent (or more) ^{240}Pu. However, minimal shielding, such as can conveniently be added to glove box operations, will significantly reduce the dose rate from these electromagnetic radiations. Pu neutron yields are basically dependent on isotopic composition, mass, chemical form and physical configuration. The mathematical expression for the neutron surface dose rate from a metal sphere is confirmed within ±25% of calculated values by the present experimental data. Personnel exposure data are evaluated on fuel fabrication operations and laboratory handling of Pu containing from approximately 18 wt % ^{240}Pu which indicate this Pu can be handled in ordinary glove boxes if special precautions and housekeeping techniques are used. Nuclide production is given on Pu isotopes and some transplutonium nuclides from Shippingport fuel which indicates the heavy nuclide production content one may expect in future high exposure fuels with from 10,000 to 30,000 MWd/tonne. (auth)

1756 (EUR-3013e) EXPERIMENTS TO EVALUATE REACTIVITY COEFFICIENTS WITH REACTOR OPERATING AT STEADY STATE CONDITIONS (STATIC EXPERIMENTS). Caldarola, L.; Haefele, W.; Schikarski, W. (Gesellschaft fuer Kernforschung m.b.H., Karlsruhe (West Germany)). 1966. 40p. Dep.

The experiments to evaluate reactivity coefficients with reactor operating a steady state conditions are described. Three reactivity coefficients are defined: the global power coefficient, G, referred to the reactor power; the global coolant temperature coefficient, γ, referred to the average coolant temperature; the secondary radial expansion temperature coefficient, γ_r, referred to the coolant temperature rise in the reactor. Each coefficient is measured by a separate experiment in which the reactivity effects due to the other two are made equal to zero. The error analysis is developed with numerical examples referred to the Southwest Experimental Fast Oxide Reactor (SEFOR). With the aim of minimizing the total error, attention is given to the choice of the best power interval for the measurement of the global power coefficient. The control philosophy of the reactor system during the experiments is also studied. (auth)

1757 (EUR-3615d(Vol.1)) ABSORBERWIRKSAMKEIT IN LEICHTWASSERMODERIERTEN REAKTOREN. (Absorber Efficiency in Light Water Moderated Reactors). Schulze, J. (Allgemeine Elektricitaets-Gesellschaft, Frankfurt am Main (West Germany)). Sept. 1967. Contract 082-66-1 TEED. 68p. (In German). Dep. CFSTI.

The results of measurements conducted, in the critical facility ALIZE at Saclay and in the AEG test reactor PR 10 at GroBwelzheim, for determination of the influence of absorbing plates on the nuclear characteristics of a core are presented. For several core

arrangements with and without absorber plates the results of the following measurements at ALIZE are reported: temperature coefficient, critical mass, three-dimensional thermal and epithermal flux distribution. The experiments at the PR 10-reactor consisted of thermal and epithermal flux measurements perpendicular to the plate for two core arrangements and several different absorbing plates. The reactivity worths of the different absorber elements have been determined for both cores utilizing pulsed neutron techniques. (auth)

1758 (EUR-3615d(Vol.2)) ABSORBERWIRKSAMKEIT IN LEICHTWASSERMODERIERTEN REAKTOREN. (Absorber Efficiency in Light Water Moderated Reactors). Baur, K. (Allgemeine Elektricitaets-Gesellschaft, Frankfurt am Main (West Germany)). Sept. 1967. Contract 082-66-1 TEED. 26p. (In German). Dep. CFSTI.

The results of experiments, carried out in the critical facility ALIZE at Saclay are compared with the results of AEG standard calculations. The methods of calculation are described. The calculated quantities are multiplication factors, coefficients of reactivity for B concentration and temperature, and distributions of neutron flux. For cores without absorber plate the measured and calculated effective multiplication factors agree within 0.006 Δk_{eff}. In the first calculations for cores with absorber plate the calculated reactivity equivalents of the absorber plates turned out to be too high. When an epithermal logarithmic surface condition $\overline{\alpha}_2 = 0.05$ was used instead of the initially calculated value $\overline{\alpha}_2 = 0.1046$, agreement between measurement and calculation would be achieved. When a more realistic energy spectrum of neutron flux at the surface of the absorber plate was used for calculating the average quantity $\overline{\alpha}_2$, the result was $\overline{\alpha}_2 = 0.055$. The deviations of the calculated coefficients for B concentration from the measured range from $+1 \cdot 10^{-5}$ to $5 \cdot 10^{-5}$ 1/mgB. The deviations of the calculated temperature coefficients range from $-3 \cdot 10^{-5}$ to $-4 \cdot 10^{-5}$ $(°C)^{-1}$. (auth)

1759 (EURAEC-1890) APPLICATIONS OF THE VAPOTRON PROCESS TO BOILING REACTORS. Final Report No. 3, 1961-1965. (Compagnie Francaise Thomson-Houston, Paris. Allgemeine Elektricitaets-Gesellschaft, Frankfurt am Main (West Germany). Kernenergieanlagen. Societe Alsthom, Paris (France)). Contracts 001-61-6-ARF; 050-62-5-RDC; 034-63-11-TEEC-CRD. 98p. (EUR-3384). Dep. CFSTI.

Work performed under United States-Euratom Joint Research and Development Program.

The VAPOTRON principle, applied since 1950 to the field of electronics, uses a heat exchange surface that is essentially anisothermal with boiling state. The study of the use of this principle with a view to improving the performance of the cooling sheaths of boiling-water reactors was the subject, from 1961 to 1964, of three successive research contracts. During the first contract, it became apparent that the VAPOTRON effect known with Cu (thermal conductivity $\lambda = 3.94$ W/cm. °C) shows itself on metals that are poor conductors, such as stainless steel ($\lambda = 0.2$ W/cm. °C), even at atmospheric pressure. The law of similar dimensions, as a function of the conductivity earlier estimated during analogous tests, was experimentally verified. The beneficial influence of the pressure was first checked with "pool boiling" up to a pressure of 70 bars: specific fluxes greater than 800 watts/cm^2 were reached in steady state with elementary specimens, with a maximum temperature-difference of 350°C between the exchange surface and the liquid. Full-scale tests in a forced-convection loop consisted of studying, producing, and then perfecting equipment, particularly a system of indirect heating, simulating as closely as possible nuclear fuel, a temperature-measuring device, a burn-out detector, and remote viewing equipment. The performances of the VAPOTRON sheaths were compared with those of smooth cylindrical sheaths. The series of measuring points obtained always corresponds, with respect to the best known results with isothermal sheaths (General Electric, Thomson), to a gain varying with the output conditions imposed, which may exceed 2 (up to 2.25 in the case of low mass velocities). (auth)

1760 (FRIGG-1) MEASUREMENTS OF HYDRODYNAMIC CHARACTERISTICS, INSTABILITY THRESHOLDS, AND BURN-OUT LIMITS FOR 6-ROD CLUSTERS IN NATURAL AND FORCED CIRCULATION. Nylund, O.; Becker, K. M.; Eklund, R.; Gelius, O.; Haga, I.; Hansson, P. T.; Hernborg, G.; Akerhielm, F. (Aktiebolaget Atomenergi, Stockholm (Sweden). Allmanna Svenska Electriska A. B., Vasteras). June 1967. 158p. Dep.

As a first step in the 8 MW FRIGG loop project for full scale tests on simulated water reactor fuel elements, a series of experiments were performed in the 2.5 MW FRÖJA loop with 6-rod clusters, simulating the central region of a boiler channel for the Marviken boiling heavy water reactor. The purpose of these experiments, and the 36-rod tests now being performed is the FRIGG loop, is verifying that the Marviken reactor can be operated at the rated power with proper safety margins against burnout or instability. The experiments are establishing an experimental basis for calculation methods to be used for future reactions. The 6-rod clusters consisted of rods with 4.4 m uniformly heated length and 13.8 mm outer diameter. Prototype reactor spacers were used. The investigations include the single and two-phase pressure drop, the axial and radial void distribution, burnout in natural and forced circulation, the natural circulation mass velocity, the stability limit as well as the details about the system during transient conditions. The results have been compared to predictions with existing correlations and models. The two-phase flow friction multiplier was found to be fairly well predicted by the Becker or the Martinelli-Nelson correlation for portions of the cluster without spacers. For the sparces a formula based on the homogeneous flow model seems to be useable. (auth)

1761 (GEAP-4809) FAST REACTOR MELTDOWN ACCIDENTS USING BETHE-TAIT ANALYSIS. Meyer, R. A.; Wolfe, B.; Friedman, N. F.; Seifert, R. (General Electric Co., Sunnyvale, Calif. Advanced Products Operation). Jan. 1967. Contract AT(04-3)-189. 85p. Dep. CFSTI.

The energy release from a meltdown accident is examined with reference to a 1000 MW(e) fast ceramic-fueled power reactor. Various reactivity insertion rates or reactivity steps are assumed, and the energy release as a function of the reactor parameters is investigated to determine the importance of these parameters and the sensitivity of the results to the assumptions that must be made. Specific parameters considered are Doppler coefficient, neutron lifetime, pressure-energy relationship for the fuel, core composition, power flattening, specific heat of the fuel, core shape, and initial conditions at the start of the reactivity input. (auth)

1762 (GEAP-5485) EVESR NUCLEAR SUPERHEAT FUEL DEVELOPMENT PROJECT. Twentieth (Final) Quarterly Report, March-June 1967. (General Electric Co., Sunnyvale, Calif. Advanced Products Operation). July 1967. Contract AT(04-3)-189. 40p. Dep. CFSTI.

An overall listing of the EVESR is presented. Fuel rod failures are tabulated; off-gas activity from failed EVESR fuels is listed. Total fuel exposure is given. Each design and developmental stage of EVESR fuels is discussed briefly. (M.L.S.)

1763 (GEAP-5533) SOUTHWEST EXPERIMENTAL FAST OXIDE REACTOR DEVELOPMENT PROGRAM. Thirteenth Quarterly Report, May-July 1967. Pflasterer, G. R. (comp.) (General Electric Co., Sunnyvale, Calif. Advanced Products Operation). Aug. 1967. Contract AT(04-3)-540. 34p. Dep. CFSTI.

The design of the SEFOR Fast Reactor Excursion Device is discussed. Results of analytical studies using both air and Ar as the working fluid with a variation in initial pressure in the accumulator chamber are given. Operating parameters of this Fast Reactor Excursion Device are presented as a function of time. The distribution of the scattering material and macroscopic scattering cross sections are shown for the SEFOR core. Sample calculations are given for the non-Doppler broadened total Pu cross sections at the center of a resonance. Results of SEFOR fuel pellet analyses are discussed. Progress on construction of SEFOR is outlined. (M.L.S.)

1764 (HMI-B-64) CHEMISCHE ASPEKTE DER REAKTORSICHERHEIT (LITERATURUEBERSICHT). 1. Halbjahresbericht im Auftrag des Bundesministeriums fuer Wissenschaftliche Forschung. (Chemical Aspects of Reactor Safety (Literature Review). First Semiannual Report on Behalf of the Government Ministery for Scientific Research). Hoinkis, E. (Hahn-Meitner-Institut fuer Kernforschung, Berlin (West Germany)). Aug. 1967. 48p. (In German). (BC-37). Dep.

A literature survey of the chemical aspects of reactor safety is presented. A discussion on fission product release and transport is presented with 23 references. Adsorption, release, and transport of fission product iodine are discussed; 22 references are given. Three references are included with an outline of work on aerosol filtration. Results of research on reactions of various metals with water are described; 8 references are given. Oxidation of graphite by steam and various aspects of corrosion are discussed; 16 references are presented. Reactions of fuel materials with water, steam, air and carbon dioxide are summarized; 10 references are given. Chemical problems associated with the handling of sodium coolants are discussed; 20 references are given. (M.L.S.)

1765 (HPR-55) WATER CHEMISTRY RESEARCH AT THE HALDEN BOILING HEAVY WATER REACTOR (HBWR). Hammar, L.; Allison, G. M.; Anderson, A. R.; Carlson, F.; Fjellestad, K.; Innvaer, R.; Rose, R. (Institutt for Atomenergi, Halden (Norway). OECD Halden Reaktor Prosjekt). June 1967. 149p. Dep.

A water chemistry program at the Halden Boiling Water Reactor (HBWR) was carried out to investigate the radiolysis of water in this type of system with emphasis on reducing net water decomposition by deuterium addition and on the use of ammonia for alkalinity control. Another main objective was to investigate the influence of water chemistry and reactor parameters on the level of ^{16}N activity in the steam. The experiments were performed at reactor powers ranging from 5 to 20 MW, corresponding to average exit steam qualities between 1.2 and 4.2%, and at pressures between 10 and 29 ata (180 to 230°C). The net rate of water decomposition amounted to between 5 and 10 ml O_2 (STP) per kg of steam. The formation of radiolytic gas was largely confined to the boiling water within the fuel channels. The concentration of radiolytic gas in the moderator was of the order of 0.05 ml O_2 per kg and increased only slightly with power. The extent of water decomposition was affected by operating conditions in a way indicating that, under normal operating conditions of the reactor, significant recombination of primarily formed decomposition products occurs in the liquid phase in combination with stripping of these products into the steam. A significant increase (of the order of 100%) of the formation of radiolytic gas per unit of radiation energy deposited in boiling water was obtained, either on promoting the rate of gas stripping into the steam, e.g., by increasing power or reducing pressure, or by addition of oxygen to the feed water to inhibit the radioinduced recombination of decomposition products. Addition of 30 ml of deuterium to the feed water per kg of raised steam, deuterium being a promotor of the recombination reactions, effected a suppression of the oxygen content of the steam, $[O_2]_{steam}$, to between 0.01 and 0.1 ml O_2 per kg. The effect of the deuterium addition was found to be related to the (average) deuterium concentration in the liquid phase of the boiling water, $[D_2]_{ch}$, approximately according to the equation $[D_2]^2_{ch}\ [O_2]_{steam} = const.$ The suppression of water decomposition obtained by deuterium addition exhibited a substantial increase with temperature, which could be largely, but not entirely, accounted for by the temperature dependence of the solubility of deuterium in water. Decomposition of ammonia (ND_3), added to the moderator, in nitrous and nitric acids was found to be prevented by maintaining a minimum concentration in the moderator of 0.2 to 0.4 ml of D_2 per kg of D_2O, dependent on power (5 to 20 MW). Under these conditions the ammonia radiolysis yielded nitrogen and deuterium at a rate proportional to reactor power and ammonia concentration but inversely proportional to the deuterium concentration; the deuterium accordingly having a protecting influence on the ammonia. On adding ammonia to the feed water, suppression of radiolytic oxygen production was obtained, which was in substantial excess of that accounted for considering the amount of deuterium added simultaneously or liberated in the radiolysis of ammonia. The distribution of ^{16}N between steam and water was found to be mainly related to the water chemistry conditions. Thus, with no additions, the steam-water distribution ratio (specific activities by weight) was about 0.06 but increased to about 0.4 with addition of deuterium and to between 1 and 8 with addition of ammonia. These effects were interpreted in terms of the chemical state of the ^{16}N under the various conditions. The results are discussed in the light of the present knowledge of radiation chemistry in aqueous solutions and current theories in this field. (auth)

1766 (IDO–17240) STEP PROJECT QUARTERLY TECHNICAL REPORT, APRIL 1967–JUNE 1967. Dietz, K. A. (ed.) (Phillips Petroleum Co., Idaho Falls, Idaho. Atomic Energy Div.). Sept. 1967. Contract AT(10-1)-205. 73p. Dep. CFSTI.

Variational synthesis techniques were used for calculation of a three-dimensional power distribution for start-of-life of the LOFT reactor. PDQ trial functions used in the TNT#2 code are discussed. Reactivity transients due to fission product poisoning are calculated. A LOFT blowdown analysis of dynamic hydraulic forces on reactor loop components is presented. A calculated fission product inventory for 20 hrs operation at 50 MW is tabulated. Effects of steam and radiation on elastomers were measured; results are tabulated. Relative iodine sorption of materials under simulated LOFT conditions is given. The performance of the continuous–sampler–monitor spray scrubber was evaluated; efficiencies are tabulated. An experimental verification of oscillatory pressure phenomena in LOFT is discussed; results are given. Processing of the LOFT semiscale blowdown data is discussed. Evaluation of a bare wire thermocouple for high temperature thermometry studies is discussed. Insulator materials for refractory metal thermocouples are evaluated. 41 references. (M.L.S.)

1767 (JUL–486-RB) WAERMEUEBERGANG UND DRUCKVERLUST AN REAKTORBRENNELEMENTEN IN FORM LAENGSDURCHSTROEMTER RUNDSTABBUENDEL. (Heat Transfer and Pressure Loss of Reactor Fuel Elements in the Form of Longitudinal Flow Through Round Rod Bundles). Presser, Karlheinz (Kernforschungsanlage, Juelich (West Germany). Institut fuer Reaktorbauelemente). June 1967. 152p. (In German). Dep.

An analysis of UO_2 fuel elements for gas-cooled graphite-moderated thermal power reactor is given. The pilot plant used for the investigation is described. The theoretical bases are established. Materials and thermal analyses are detailed; results of these measurements are discussed. Effects of geometry and size on isothermal pressure losses are analyzed; measurements and analyses are detailed. 113 references. (M.L.S.)

1768 (K–1724) NUMERICAL SOLUTION OF A SYSTEM OF ORDINARY AND NON-LINEAR PARTIAL DIFFERENTIAL EQUATIONS. Lick, Dale W.; Tunstall, J. Nelson (Union Carbide Corp., Oak Ridge, Tenn. Computing Technology Center). Oct. 30, 1967. Contract W-7405-eng-26. 52p. Dep. CFSTI.

A system of two linear first-order ordinary and two nonlinear second-order partial differential equations with mixed boundary conditions is considered. Solutions by both linear and nonlinear numerical methods are discussed and compared. The equations arise from a description of the simultaneous chemical reaction and convective-diffusive transport of water vapor and hydrogen through a graphite cylinder. Although specifically written for the steam-graphite system, the equations may have applications to general systems of fluid flow coupled with chemical reactions. (auth)

1769 (NUS–405) REACTOR OPERATION'S SAFETY ANALYSIS MONTHLY REPORT NO. 25, JULY 1 TO JULY 31, 1967. (NUS Corp., Washington, D. C.). Contract AT(11-1)-651; Subcontracts No. 4 and 5. 53p. Dep. CFSTI.

For Rural Cooperative Power Association, Elk River, Minn.

Topics discussed include: secondary system and turbine air ejector activity levels; plant radiation levels; dispersion of gaseous waste discharges from atmospheric dilution; primary water chemistry and radiochemistry; and Cycle 3 refueling and physics test results. (D.C.C.)

1770 (ORNL–4172) OPTIMIZATION PROBLEM IN NUCLEAR REACTOR ECONOMICS. Nelson, Paul (Oak Ridge National Lab., Tenn.). Oct. 1967. Contract W-7405-eng-26. 17p. Dep. CFSTI.

A simple model is formulated of a nuclear reactor power system required to supply a specified power demand. Necessary and sufficient conditions for feasibility are found. A certain construction is described and shown to yield a policy of minimum cost for any data under which feasible policies exist. (auth)

1771 (ORNL–4180) REMOVAL OF RADIOACTIVE METHYL IODIDE FROM STEAM–AIR SYSTEMS (TEST SERIES II). Ackley, R. D.; Adams, R. E. (Oak Ridge National Lab., Tenn.). Oct. 1967. Contract W-7405-eng-26. 23p. Dep. CFSTI.

A series of tests concerned with the removal of radioactive methyl iodide from flowing steam-air by specially impregnated charcoals is described. Most of the effort has been directed toward evaluating the $CH_3{}^{131}I$ removal (actually ^{131}I of $CH_3{}^{131}I$ removal) capabilities of commercial iodized charcoals which are useful for this purpose via an isotopic exchange reaction in addition to the adsorption processes peculiar to the charcoal. Two types of commercial iodized charcoal were effective for $CH_3{}^{131}I$ trapping at conditions as severe as 280°F, 60 psia, and 90% relative humidity. Three additional types of commercial iodized charcoal, two varieties of laboratory-impregnated iodized charcoal, and two charcoal-based oxidizing catalysts were tested with respect to $CH_3{}^{131}I$ removal from flowing steam-air. The three types of commercial iodized charcoal also were found to be effective for $CH_3{}^{131}I$ trapping in steam-air systems. Useful trapping capability was observed at relative humidities higher than 90%, but at relative humidities indicated to be at or near 100% appreciable losses in $CH_3{}^{131}I$ removal efficiency were frequently observed. The two laboratory-impregnated iodized charcoals were investigated to determine if certain variations in their preparation might improve their qualities as trapping agents at very high relative humidity. According to the results obtained, neither of these two materials appeared to represent a solution to the problem associated with operations at very high relative humidity. The two charcoal-based oxidizing catalysts were found to be relatively inefficient as compared to the performance of suitably impregnated iodized charcoal. (auth)

1772 (ORNL-TM–1986) ORNL NUCLEAR SAFETY RESEARCH AND DEVELOPMENT PROGRAM. Bimonthly Report, July–August 1967. Cottrell, Wm. B. (Oak Ridge National Lab., Tenn.). Sept. 21, 1967. Contract W-7405-eng-26. 115p. Dep. CFSTI.

Brief summaries of the ORNL nuclear safety research and de-

velopment programs are presented. Areas of concentration include: water reactor program—chemical reactions and engineered safeguards; LOFT support work, ignition of charcoal adsorbers in reactor accidents; chemical aspects of gas-cooled reactor safety; pressure vessel and piping technology; standards, criteria, and analytics of safety hazards. (M.L.S.)

1773 (PRDC-EF-48) POWER REACTOR DEVELOPMENT COMPANY, ENRICO FERMI ATOMIC POWER PLANT REPORT FOR AUGUST 1967. (Power Reactor Development Co., Detroit, Mich.). Contract AT(11-1)-476. 8p. Dep. CFSTI.

Subjects discussed from August operations include: fuel handling and inspection; sodium draining; radiation monitoring for health physics; maintenance and modifications; and component and systems testing. (D.C.C.)

1774 (PRWRA-115) REACTOR OPERATIONS AT THE BONUS PLANT. Monthly Report No. 6. (Puerto Rico Water Resources Authority, San Juan). June 1967. Contract AT(40-1)-2672. 37p. (WRA-B-67-16). Dep. CFSTI.

Full power operation and identification of the building airborne contamination sources are reported. Significant progress was made in identifying the sources of airborne contamination and corrective measures were taken where appropriate. Five reactor shutdowns occurred during the report period; one of them was an intentional scram made in order to gather data related to the airborne contamination under those conditions. Two of the shutdowns were caused by problems with the motor-generator set; another one was caused by a trip of a safety dc circuit due to excessive current in the circuit induced by lightning; and the other one was a scram that resulted due to an operator error after an orderly shutdown had been initiated to correct excessive arcing of the motor generator set brushes. Two reactor control rods (blade rods Nos. 13 and 14) were modified to provide additional drop safety margin and to prevent high mechanical stresses in the snubbers. (auth)

1775 (RT/FI-(67)23) LIFE EFFECTS ON THE PERFORMANCE OF CERAMIC FAST BREEDERS. Gandini, A.; Leo, M.; Salvatores, M. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 1967. 15p. Dep.

The sodium void coefficient, the Doppler effect and the prompt neutron lifetime calculations for the oxide pancake and the carbide system fast ceramic reactors are presented. The use of multigroup diffusion methods and generalized perturbation techniques are described. (D.C.C.)

1776 (WCAP-3680-5) CONTROL OF XENON INSTABILITIES IN LARGE PWR'S QUARTERLY PROGRESS REPORT FOR THE PERIOD ENDING SEPTEMBER 30, 1967. (Westinghouse Electric Corp., Pittsburgh, Pa. Atomic Power Div.). Oct. 1967. Contract AT(30-1)-3680. 10p. (EURAEC-1925). Dep. CFSTI.

Work Performed under United States-Euratom Joint Research and Development Program.

The analyses of effects of core parameters on spatial oscillations are summarized. Diametral analyses and x-y transient analyses of xenon instabilities are discussed. (M.L.S.)

1777 (WCAP-3696-5) PRESSURIZED WATER REACTOR pH-REACTIVITY EFFECT. Quarterly Progress Report for the Period Ending September 30, 1967. (Westinghouse Electric Corp., Pittsburgh, Pa. Atomic Power Div.). Oct. 1967. Contract AT(30-1)-3696. 41p. (EURAEC-1926). Dep. CFSTI.

Work Performed under United States-Euratom Joint Research and Development Program.

Fabrication of the instrumented 3 × 3 subassembly for use in Saxton Power Reactor is described. Evaluation and nondestructive testing of the fuel tubes is discussed. A description of the reactivity oscillator for dynamic measurements is given. (M.L.S.)

1778 (WCAP-6085) YANKEE CORE EVALUATION PROGRAM. Quarterly Progress Report for the Period Ending June 30, 1967. O'Boyle, M. J. (Westinghouse Electric Corp., Pittsburgh, Pa. Atomic Power Div.). Oct. 1967. Contract AT(30-1)-3017. 56p. Dep. CFSTI.

Results of mass spectrometric determination of ^{137}Cs content in Yankee core fuel samples are listed. Analyses of fuel burnup samples for ^{236}Pu and ^{238}Pu are presented. Americium and Curium content in fuel burnup samples is given. Use of the LASER computer code for burnup analyses is discussed. The mathematical formulation of the LASER program is developed. Burnup sample analyses atom percents and mass ratios of ^{235}U, ^{236}U, and Pu are tabulated. The evaluation of the ^{148}Nd burnup indicator is discussed. (15 references). (M.L.S.)

1779 CALCULATION OF FISSION-PRODUCT GAS PRESSURES IN OPERATING UO_2 FUEL ELEMENTS. Notley, M. J. F. (Atomic Energy of Canada Ltd., Chalk River, Ont.). Nucl. Appl., 3: 334-42(Oct. 1967).

A method has been evolved for the calculation of the fission-product gas pressure inside operating UO_2 fuel elements. The calculations are based on a model in which the hot center of the UO_2 pellet is assumed to flow plastically under stress, and the outer annulus is cracked. The calculated pressures are shown to be in reasonable agreement with experimental measurements of the gas pressure inside fuel elements. (auth)

1780 CRITICAL CRACK-LENGTH MEASUREMENTS IN HYDRIDED ZIRCALOY-2 PRESSURE TUBES. Cowan, A.; Cowburn, K. J. (United Kingdom Atomic Energy Authority, Culcheth, Eng.). J. Inst. Metals, 95: 302-7(Oct. 1967).

Tests on Zircaloy-2 pressure tubes in which slits have been cut through the wall thickness before pressurizing to failure are described. Up to 300°C, failure occurred by fast propagation of cracks initiated at the ends of the slits. Increasing the hydrogen content of the tubes caused embrittlement, with a decrease in the critical crack length, i.e., the slit length for failure at a given stress. The embrittlement was greatest at room temperature; ductility increased with temperature until, at 300°C, the effect of 400 ppM hydrogen was comparatively small. The critical crack length is of the order of 4 in. at the operating temperature and pressure of the S.G.H.W. reactor (300°C, 16,000). This length is orders of magnitude greater than the length that can be detected in service and is also greater than the length of defect that would be expected to give rise to slow leakage before failure. Over the range measured, the critical crack length (l) to failure stress (f) relationship approximates to $f^n l$ = constant. The values of n are <2, indicating that application of linear elastic fracture mechanics (n = 2) to tube failure will lead to an optimistic estimation of the critical crack length over the failure-stress range examined. (auth)

1781 COMPARATIVE PARTICLE-SIZE PROFILES OF SOME MATERIALS OF INTEREST IN ATOMIC ENERGY FUEL FABRICATION PROCESSES. Smith, G.; Ferrett, D. J. (Atomic Energy Establishment, Winfrith, Eng.). pp 344-54 of Particle Size Analysis. London, Society for Analytical Chemistry, 1967.

From Conference on Particle Size Analysis, Loughborough, Eng., Sept. 14-16, 1966. See CONF-660954.

Uranium dioxide and graphite are used extensively at the Atomic Energy Establishment, Winfrith, for fabrication of reactor physics samples. The determination of the particle-size profiles as revealed by β-backscattering, Coulter Counter A, and centrifugal photosedimentometry are described. It is demonstrated that agreement is obtained by different techniques for the mean particle size of a graphite sample to about 1 μ. The particle size distribution for uranium dioxide as determined by photosedimentometry shows deviations at higher particle sizes, and these discrepancies are discussed. The relations to observations made by visual and electron microscopy of these materials are also considered. (auth)

1782 EXAMPLES OF TECHNOLOGICAL PROGRESS ON THE OCCASION OF THE COMPLETION OF THE REACTOR EL-4. Gibrat, M. R.; DuPuy, M. J. C. Bull. Inform. A.T.E.N. (Ass. Tech. Energ. Nucl.), No. 67, 32-8(Sept.-Oct. 1967). (In French).

Technological accomplishments represented by the completion of the French EL-4 reactor are outlined. Utilization of high temperatures and high pressures for circulation of the carbon dioxide, automation of control circuits, and reactor control by neutron absorbing gases are discussed. (M.L.S.)

1783 REACTOR NOISE IN HETEROGENEOUS SYSTEMS. I. PLATE-TYPE ELEMENTS. Williams, M. M. R. (London Univ.). Nucl. Sci. Eng., 30: 188-98(1967).

A formalism based upon the source-sink method of Horning, Feinberg, and Galanin has been developed which predicts the neutron noise spectrum and time-dependent correlation function in heterogeneous reactor systems. The method is applied to two problems in infinite plane geometry: the infinite lattice, and detector perturbations. In the lattice problem, it is shown that the simple, homogeneous theory will only be valid when the lattice spacing is very much less than the attenuation length of a neutron wave in the pure moderator. The flux depression in the neighborhood of a neutron detector is found to introduce significant corrections to the noise spectrum. 10 references. (auth)

1784 ROVI PROJECT. Lazzarino, Lucio; di Menza, Raffaele (Univ., Pisa, Italy). Com. Naz. Energ. Nucl., Notiz., 13: No. 7, 47-54(July 1967). (In Italian).

The ROVI project has the purpose of evaluating an organic-cooled and -moderated reactor for the production of low temperature steam for use in a distillation plant. The reactor design is given and the principal characteristics are tabulated. The capital cost and operational cost are evaluated. An evaluation of the reactor capacity for the production of low temperature steam and for distillation of sea water was made on an economic basis. The re-

sults showed that the ROVI reactor has a clear advantage in the field between 100 and 400 MW(t), equivalent to plants with approximate capacity between 50,000 and 200,000 m^3/day. (J.S.R.)

1785 COMMENTS ON THE COMPARISON BETWEEN CROSS- AND AUTOSPECTRAL DENSITY MEASUREMENTS IN NUCLEAR REACTORS. Seifritz, W.; Stegemann, D. (Kernforschungszentrum, Karlsruhe, Ger.). Nukleonik, 10: 158-61 (1967). (In German).

A method of error analysis for cross-spectral density and autospectral density measurements is presented. This method takes into account relative error in cross-spectral density and autospectral density due to statistical fluctuations of detector signal and relative error due to inaccuracies of electronic equipment components. A comparison of the two techniques on the basis of relevant errors is made. Equipment requirements for both techniques are discussed. (M.L.S.)

1786 BRITISH PAPER TO AMERICAN NUCLEAR SOCIETY ON THE ADVANCED GAS-COOLED REACTOR. Brown, G.; Warner, P. C. (Atomic Power Constructions Ltd., Sutton, Eng.). Neue Tech., 9: 148-9(Aug. 1967).

Current progress of Britain's first commercial Advanced Gas-cooled Reactor Station at Dungeness is discussed. The basic gas-cooled design is reviewed; economics of these systems is briefly discussed. (M.L.S.)

1787 NUCLEAR ENERGY IN SPAIN. PART I. INVESTIGATION OF NUCLEAR ENERGY IN SPAIN. PROGRAM OF THE NUCLEAR ENERGY COMMISSION. Rodriguez, M. Lopez (Junta de Energia Nuclear, Madrid). Neue Tech., 9: 154-65 (Aug. 1967). (In Spanish).

A brief history of nuclear energy in Spain is given. Nuclear activities and research centers are outlined. The uranium reserves are discussed; fuel element fabrication programs are outlined. A brief description of the Spanish reactors is given. A general outline of the nuclear engineering program is presented. (M.L.S.)

1788 THERMAL EFFICIENCY OF STEAM-COOLED REACTORS WITH EXTERNAL FEEDWATER EVAPORATION. Schaer, R. (International Atomic Energy Agency, Vienna). Neue Tech., 9: 165-9(Aug. 1967). (In German).

Various circuits for direct-cycle steam cooled reactors with external feedwater evaporation are compared. Principal schematics and process diagrams are presented for the various steam circulating processes. (M.L.S.)

1789 ON THE GENERALIZED ALBEDO METHOD. Vertes, Peter (Central Research Inst. for Physics, Budapest). Nukleonik, 10: 148-53(1967).

The albedo method is presented in its general form. Albedo operators are defined for regions of any shape and of any transport properties. The basic addition formulas are given in general case; for the stationary case a criticality equation making use of the albedo operators is derived. A method of expansion of the albedo operators in orthogonal series is shown which facilitates the numerical applications of the theory. The main fields of application to reactor physics problems are outlined. (10 references) (auth)

1790 PRESTRESSED CONCRETE PRESSURE VESSELS FOR A 250 Mw(e) HEAVY WATER MODERATED AND CARBON DIOXIDE COOLED REACTOR. Lafitte, Raymond (Bonnard and Gardel, Lausanne, Switzerland); Khan, Mukhtar Hussain; Merot, Jean Paul; Tarbes, Bernard. Nucl. Eng. Design, 6: 163-80 (1967).

The design and cost evaluation of three cylindrical prestressed concrete pressure vessels (PCPV) for a heavy water moderated, gas cooled reactor of 250 MWe carried out in 1965-1966 on behalf of the Swiss "Société nationale pour l'encouragement de la technique atomique industrielle." The vessel shapes are discussed; the internal dimensions of the three vessels examined are: 15 m diameter, 16 m height with 60 bars pressure for a metallic U reactor with radially arranged heat exchangers; 11 m diameter, 35 m height with 60 bars pressure for a metallic U reactor, and 9 m diameter, 26 m height with 90 bars pressure for a UO_2 reactor, both with vertical arrangement of reactor and heat exchangers. The internal components of the three vessels are also briefly described. The different loading conditions are presented. The design philosophy and safety criteria are outlined. The structural analysis and design of the three PCPVs is given. The prestressing cable layouts are described. The results of ultimate load analysis are also given. The results of the estimate of the materials quantities and the costs of the three PCPVs are given. Also indicated are the variation of the cost of these vessels with the variation of pressure, diameter and height not exceeding 10% of the examined values. (auth)

1791 ANALYTICAL METHODS USED IN THE PRELIMINARY ANALYSIS OF THE TRANSIENT BEHAVIOR OF THE HWOCR. Coppersmith, W. C.; Harding, R. S.; Hencey, T. R. (Combustion Engineering, Inc., Windsor, Connecticut). Nucl. Eng. Design, 6: 134-8(1967).

Methods used for analyzing both long and short term transients for Heavy Water Organic Cooled Reactor (HWOCR) designs are discussed. Along with the conventional point kinetics methods, a one-dimensional space-time method was employed for short term transients, and a one-dimensional modal method as well as a two-dimensional finite difference method was used for studying xenon-induced spatial power oscillations. (10 references) (auth)

1792 EVESR POWER DISTRIBUTION AND THERMAL-HYDROLIC ANALYSIS. Bader, Manfred B.; O'Neill, G. L. (General Electric Co., Sunnyvale, Calif.). Nucl. Eng. Design, 6: 115-33(1967).

A brief survey of the EVESR (ESADA Vallecitos Experimental Superheat Reactor) is given. Two different types of superheat fuel elements — Mark II and Mark III — irradiated in EVESR are described. Definitions as well as experimental and theoretical methods are presented to establish the EVESR core power distribution in order to form the basis for the thermal-hydraulic core analysis. Thermal-hydraulic methods applied to the EVESR core are demonstrated by examples of three failed fuel elements, one Mark II type and two Mark III types. Methods and results are discussed. (22 references) (auth)

1793 TRANSIENT SODIUM BOILING CALCULATIONS. II. MacFarlane, D. R. (Argonne National Lab., Ill.). Nucl. Eng. Design, 6: 103-14(1967).

Methods and results of a theoretical investigation of Na expulsion from a reactor core due to boiling, using the basic equations of hydrodynamics and limited to transients which are slow enough so that coolant boiling occurs before the fuel surface or cladding melts are presented. The model and computational scheme described earlier has been modified to permit: Coolant boiling to start at an arbitrary point in the channel instead of only at the exit and calculation to continue beyond the point of flow reversal at the channel inlet. The results of calculations for power increase and flow decay transients in typical oxide and carbide fueled fast breeder reactor channels show that higher coolant velocities and pressures are obtained with the higher power density carbide fuel. (auth)

1794 HISTORY OF THE NORSE-NETHERLANDS COOPERATIVE IN THE AREA OF NUCLEAR ENERGY. V. Goedkoop, J. A. Atoomenergie Haar Toepass., 9: 151-68 (July-Aug. 1967). (In Dutch).

The studies made by the joint establishment for nuclear energy research before 1959 were sketched. The history of the Norse-Netherlands Cooperative since then is described. (tr-auth)

1795 SURVEILLANCE OF NUCLEAR POWER REACTORS. Weaver, Charles L.; Harward, Ernest D. (Public Health Service, Washington, D. C.). Public Health Rep. (U. S.), 82: 899-912 (Oct. 1967).

A generalized concept of nuclear power plants, particularly as they pertain to public safety and environmental surveys, is given. Simplified flow diagrams for a typical boiling water reactor and a typical pressurized water reactor are shown. Biological properties of important radionuclides are listed; fission products which are important due to atom yield or half life are tabulated. Surveillance methods for reactor pre-operational and operational phases are outlined. A typical environmental surveillance program is given. Emergency procedures are discussed briefly. (M.L.S.)

1796 EUROPEAN EXPERIMENTAL PROGRAMMES OF THE FAST REACTORS AND FURTHER REALIZATIONS. Hurst, R. Energ. Nucl. (Paris), 9: 271-4(June-July 1967). (In French).

The European programs for the development of fast reactors and their probable future are described briefly. (J.S.R.)

1797 PROGRAMMES AND ECONOMY OF THE EUROPEAN FAST REACTORS. Berridge, D. R. Energ. Nucl. (Paris), 9: 275-8(June-July 1967). (In French).

The economics of fast reactors are considered with respect to the price of Pu and the cost of the energy produced. The rate of installation of fast reactors is evaluated with respect to the site selection, the construction of thermal reactors, and the cost of uranium. (J.S.R.)

1798 BLACK-WHITE MODEL FOR INCLUDING EPITHERMAL ABSORPTION IN CALCULATIONS OF CONTROL-ROD WORTH. Spinks, N. (Australian Atomic Energy Com-

mission Research Establishment, Lucas Heights, New South Wales). Nucl. Sci. Eng., 30: 176-81(1967).

Epithermal absorption by control rods in nuclear reactors is taken into account by replacing the black-grey-transparent rod by a black-transparent model. The lethargy boundary, in the model, is determined for 1/v absorbers by the prescription that: at the boundary, half the incident partial current is absorbed by the rod. Application of the model to space-independent spectrum calculations improves the calculation to the extent that, provided the black-transparent boundary is the boundary between the groups, two-group methods can be used for control rods in bare reactors. For control rods in reflected reactors, three groups are indicated. Calculations are presented to demonstrate the accuracies of the black-transparent model and the small number of neutron energy groups. 8 references. (auth)

1799 COMPETITIVITA CONVERSIONE E BREEDING LE GRANDI TAPPE DELL'ENERGIA NUCLEARE, MILANO, 15–17 DICEMBRE 1966. (Competitive Status of Conversion and Breeding of Nuclear Power. On the Conference on Nuclear Energy, Milan, Dec. 15-17, 1966). Rome, Comitato Nazionale Energia Nucleare, 1967. 466p. (CONF-661213).

Papers from a conference on technological and economic aspects of nuclear energy are presented. Information presented is of a general, descriptive nature. Separate abstracts are prepared for the 16 papers presented. One paper was abstracted previously, see CONF-661213. (M.L.S.)

For abstracts of individual papers see: 1800–1815.

1800 NEW ECONOMIC PERSPECTIVES OF NUCLEAR ENERGY IN EUROPE. Michaelis, H. (EURATOM, Brussells). pp 47-86 of Competitivita Conversione e Breeding le Grandi Tappe Dell'Energia Nucleare. Rome, Comitato Nazionale Energia Nucleare, 1967. (In French).

From 9th International Meeting on Nuclear Energy, Milan, Dec. 15–17, 1966. See CONF-661213.

A survey of the development of nuclear energy in the European Atomic Energy Community is discussed. Nuclear capacities in operation at the present time total 1750 MWe, plants under construction 2250 MWe and plants the construction of which is projected or has been decided upon, about 4000 MWe. It goes on to point out that 600 MWe light-water power plants of the latest technical design give electricity-generating costs of 4.75 mill/kWh. Graphite-gas and AGR power plants can achieve similar generating costs with technical improvements. In the case of heavy-water-moderated and gas-cooled high-temperature reactors, a 10 and perhaps 20 percent saving will be possible under this head. Fast breeder reactors may be expected to come into industrial use around 1980. The Euratom Commission is now examining the advisability of adhering to its nuclear-energy development model with three reactor generations (proven reactors, advanced converters and fast breeders). From a preliminary investigation it emerges that the introduction of advanced converters will as before offer a certain advantage over a development pattern in which proven reactor types give place immediately to fast breeders. Another factor is that heavy-water-moderated reactors use less uranium and have a higher plutonium yield. On the basis of the available data, proven-type nuclear power plants of the most sophisticated type generate electricity at the same cost as conventional thermal plants. The Euratom Commission has raised its nuclear energy capacity target for 1980, i.e., 40,000 MWe, to 60,000 MWe. A survey of the fuel-supply position, considering necessary to commission new uranium-enrichment plants before 1980, is given. (auth)

1801 REPORT ON COMPETITIVITY AS ACHIEVED IN THE UNITED STATES. Hoyle, D. B. (Atomic Energy Commission, Washington, D. C.). pp 87-100 of Competitivita Conversione e Breeding le Grandi Tappe Dell'Energia Nucleare. Rome, Comitato Nazionale Energia Nucleare, 1967.

From 9th International Meeting on Nuclear Energy, Milan, Dec. 15–17, 1966. See CONF-661213.

During 1966, large nuclear power reactors attained competitive status with comparable conventional plants in almost all geographical areas of the United States. It is expected that nuclear plants will account for 60 to 70 percent of future additions to electrical power generating capacity in thermal plant sizes of 400 MWe or larger. The evolution of this trend and its effect on the nuclear power growth rate projections is developed by a comparison of the AEC's 1962 Report to the President, the 1964 Jersey Central Oyster Creek Study and the 1966 TVA Browns Ferry Analysis. (auth)

1802 INTEGRATION OF THERMAL AND FAST REACTORS IN A NUCLEAR POWER PROGRAMME. Hill, J. M. (United Kingdom Atomic Energy Authority, London). pp 129-44 of Competitivita Conversione e Breeding le Grandi Tappe Dell'Energia Nucleare. Rome, Comitato Nazionale Energia Nucleare, 1967.

From 9th International Meeting on Nuclear Energy, Milan, Dec. 15–17, 1966. See CONF-661213.

The advantages of the fast reactor in a nuclear power program are outlined; the fast reactor is shown to be the system most likely to achieve high utilization of fissile and fertile material. It compares the physics of the fast reactor system with the competing Th/^{233}U thermal system and with the simpler but lower efficiency natural and slightly enriched U systems. The requirements of U for a fast reactor program are so small in relation to their production of electricity that extraction of U from abundant low grade ores, or from sea water, would be economically justified. It is widely accepted that the Pu fueled fast reactor is likely to make a major, if not the principal contribution to nuclear power generation in the longer term. The subject on which there is the greatest uncertainty is the time required to solve the technological difficulties that have yet to be overcome. In the shorter term we will have the problems of excess Pu stocks which will result from the operation of the present generation of thermal reactors and which will inevitably build up to a substantial scale on a worldwide basis during the 1970's. The present status of the fast reactor and the main technological problems still to be solved are discussed. Possible time scales for the introduction of the fast reactor system are presented. The economics of using Pu in thermal reactors or fast reactors is also discussed. (auth)

1803 THE ALTERNATIVE OF PLUTONIUM–URANIUM ENRICHMENT AS A SPIN-OFF DEVELOPMENT OF FAST REACTORS. Banal, M. (Electricite de France, Paris); Zaleski, P. pp 145-64 of Competitivita Conversione e Breeding le Grandi Tappe Dell'Energia Nucleare. Rome, Comitato Nazionale Energia Nucleare, 1967. (In French).

From 9th International Meeting on Nuclear Energy, Milan, Dec. 15–17, 1966. See CONF-661213.

The report makes a comparison of the technical characteristics of the power fast reactors that use ^{235}U or Pu fuel, with particular reference to their critical mass, regeneration ratio, reactivity evolution, etc. The technical demonstration value of a fast reactor prototype that uses ^{235}U fuel is discussed; economic considerations on this utilization in the above named reactors are developed. The report presents a long term plan for development of the fast reactors and thermal reactors; the Pu availability and application of this program to the French economy is considered. (auth)

1804 ACHIEVEMENTS AND PROSPECTS OF HEAVY WATER REACTORS. Lewis, W. B. (Atomic Energy of Canada, Chalk River). pp 167-84 of Competitivita Conversione e Breeding le Grandi Tappe Dell'Energia Nucleare. Rome, Comitato Nazionale Energia Nucleare, 1967.

From 9th International Meeting on Nuclear Energy, Milan, Dec. 15–17, 1966. See CONF-661213.

A hundred years from now various types of nuclear power stations will be in operation and in competition with each other. Large heavy-water reactors promise to compete strongly with all other types, including any breeders, for supplying heat and electricity. Capital costs will not be high and will be comparable for all large nuclear stations. Fuel-cycle and operating costs will total perhaps only a quarter of the cost of electric power. For neutron-economical heavy-water reactors these costs will be low because of the relatively low fuel inventory and the high burnup in fissions per initial fissile atom (FIFA) before processing. Processing will contribute only a small cost because of the high FIFA and because—by that time—operations will be on a large scale. If, as expected, the price of U has risen, the preferred fuel cycle is likely to involve the sequence: natural U, Pu + Th, ^{233}U + Th. Irradiation times will be selected to minimize the overall fuel-cycle costs. The sequence of fuel cycles would be practicable in the heavy-water reactors now being designed and built to employ natural U without reprocessing. Seven natural-U heavy-water power reactors of the Canadian designs with on-power fuelling are in operation or under construction, and more are planned. (auth)

1805 THE DEVELOPMENT OF HEAVY WATER REACTORS IN FRANCE. Bailly du Bois, B. (CEA, Saclay, France). pp 185-202 of Competitivita Conversione e Breeding le Grandi Tappe Dell'Energia Nucleare. Rome, Comitato Nazionale Energia Nucleare, 1967. (In French).

From 9th International Meeting on Nuclear Energy, Milan, Dec. 15–17, 1966. See CONF-661213.

The object of the development studies carried out since 1959 was the physical, technological and industrial problems that concern the different types of heavy water reactors. The efforts were more particularly devoted to CO_2 cooled piles; these works brought to the development of the EL-4 reactor prototype. The construction

of the EL-4 prototype started in July 1962. In spite of some difficulties the first start-up of the pile will take place before the end of 1966, that is with a slight delay in comparison with the initial planning. The first charge fuel elements sheathed with stainless steel must be gradually replaced by the elements sheathed with Zr alloy. (auth)

1806 DEVELOPMENT OF HEAVY WATER REACTORS IN GERMANY. Braun, W. (Siemens-Schuckertwerke A. G., Erlanger, Ger.). pp 203-15 of Competitivita Conversione e Breeding le Grandi Tappe Dell'Energia Nucleare. Rome, Comitato Nazionale Energia Nucleare, 1967.

From 9th International Meeting on Nuclear Energy, Milan, Dec. 15–17, 1966. See CONF-661213.

The MZFR, a 50 MWe D_2O moderated and cooled natural U PWR at Karlsruhe has now successfully finished its test runs and is on the grid. It represents a first step in the development of heavy water power reactors in Germany. To extend the basis of available D_2O-reactor technology a design study on a CO_2 cooled, D_2O moderated pressure-tube reactor in early 1966 finally led to the construction of the 100 MWe KKN project, formerly known as "AKB." KKN will be in operation in early 1970. Design studies are aimed at increasing the maximum unit design power of MZFR to 500 MWe and up, decreasing its specific D_2O inventory, and reducing its possible D_2O losses. An indirect cycle boiling D_2O cooled, D_2O moderated natural U reactor system was considered. The integrated scheme with a prestressed concrete pressure vessel was adopted. The excellent neutron economy of D_2O moderated and cooled pressure vessel reactors makes this type an attractive thermal Th breeder. Further improvements of the CO_2 cooled D_2O moderated reactor concept can be obtained through the use of natural U. For this purpose a low absorbent canning material, as ZrCu or Be, is being presently developed. The interest in this type of reactor further points into the direction of a gas-cooled fast breeder reactor. (auth)

1807 SWEDISH VESSEL BHWRs: EXPERIENCE AND PROSPECTS. Margen, P. H. (Aktiebolaget Atomenergie, Stockholm). pp 217-43 of Competitivita Conversione e Breeding le Grandi Tappe Dell'Energia Nucleare. Rome, Comitato Nazionale Energia Nucleare, 1967.

From 9th International Meeting on Nuclear Energy, Milan, Dec. 15–17, 1966. See CONF-661213.

The impact on HWR prospects of new factors: the LWR order boom; the rapidly increasing unit sizes; the increasing predictions of world U requirements—are discussed. The first of these factors works against development—demanding non-water-coolant HWRs, while the other two factors strongly improve HWR prospects, particularly for variants with good neutron economy and designs cheaply expandable to large unit sizes. Swedish pressure vessel designs use established LWR technology to a maximum degree and experience with these designs has been favorable. High availability and extraordinarily low heavy water leakage has been demonstrated at the Ägesta station. Good progress is reported for the 200 MWe Marviken BHWR planned for commissioning in 1968. The pressure vessel has undergone its overpressure tests and the project is on schedule. Work on new BHWRs has taken account of the trends mentioned above—maximum simplicity and low marginal cost designs, concrete pressure vessels to allow unlimited size expansion, good neutron economy with minimum of structural material in core and on-line refuelling. Various heavy water reactor fuel cycles are discussed including an adoption to vessel reactors of the "tandem" LWR/HWR fuel cycle, in which fuel assemblies irradiated in BWRs are transferred, as they are to BHWRs for further irradiation. Large net economic benefits are obtained compared to LWR stations even for quite small unit sizes. Natural U BHWRs are competitive with LWRs for the unit sizes being selected for the larger power units on order in Europe today, and will achieve important economic gains relative to LWRs with the unit size, fabrication cost and U price trends predicted for the future. (auth)

1808 THE ORGEL PROJECT. Leny, J. C. (EURATOM, Ispra, Italy). pp 244-65 of Competitivita Conversione e Breeding le Grandi Tappe Dell'Energia Nucleare. Rome, Comitato Nazionale Energia Nucleare, 1967. (In French).

From 9th International Meeting on Nuclear Energy, Milan, Dec. 15–17, 1966. See CONF-661213.

The studies carried up by Euratom on an ORGEL prototype reactor are based on the results of the whole experimental works concerning SAP, the organic coolant, fuel and channel. The coolant was particularly studied as regards radiolysis, radiopyrolysis and the purification problems that come from them. The reference fuel element is formed by a compact cluster of 19 UC rods sheathed with SAP. The technical and economic characteristics are shown of three ORGEL power plants, the rating of which is 500 gross MWe each, that are optimized according to three different techniques. The influence of either the natural or enriched fuel is studied on the reference power plant as well as the size effect. (auth)

1809 THE STEAM GENERATING HEAVY WATER REACTOR SYSTEM. Firth, A. (United Kingdom Atomic Energy Authority, Risley, Eng.). pp 267-84 of Competitivita Conversione e Breeding le Grandi Tappe Dell'Energia Nucleare. Rome, Comitato Nazionale Energia Nucleare, 1967.

From 9th International Meeting on Nuclear Energy, Milan, Dec. 15–17, 1966. See CONF-661213.

The Steam Generating Heavy Water Reactor system offers low capital cost, uses fuel at low enrichment and has competitive generating costs over a wide range of sizes. The 100 MWe SGHWR power station at Winfrith Heath is now in its commissioning phase. Construction of the station has demonstrated that it is possible to work to a short site construction time and that normal fossil fuel type power station erection procedures are adequate. The SGHWR system can be designed to use either natural or enriched U and for either on-load or off-load refuelling. Because individual channels are accessible, off-load refuelling can be carried out in a period of about two days and does not therefore incur a significant outage penalty. A typical multi-batch refuelling system requires an initial enrichment of about 1.25% and a mean feed enrichment of about 2%. The mean reject enrichment is below that at which the U has zero value. Further development of the system will be confirmed during the early stages of the prototype operation, including higher fuel ratings and the conditions appropriate to a ferritic primary circuit. Designs of commercial stations of around 300 MWe output are now available and in these designs there has been simplification of the core components with a consequent reduction in cost and a further reduction in site erection time. Many of the features of an SGHWR designed for enriched fuel are applicable to a design for natural U fuel. The control and fuel management are different, however, and these features are now being developed. (auth)

1810 OUTLINES OF THE CIRENE PROGRAM. Silvestri, M. (CISE, Milan). pp 285-301 of Competitivita Conversione e Breeding le Grandi Tappe Dell'Energia Nucleare. Rome, Comitato Nazionale Energia Nucleare, 1967. (In Italian).

From 9th International Meeting on Nuclear Energy, Milan, Dec. 15–17, 1966. See CONF-661213.

The Cirene Project is described. This project is based on the principle of a heavy cold water moderated reactor, utilizing natural U as fuel, and natural water in change of phase, as coolant. It is a direct cycle plant. The research and development program is in course of completion, and the construction of a prototype unit is scheduled to take place very soon. This prototype, of a power of 31 net MWe, will cost about 26 million dollars, inclusive of all charges. The activity connected with the development of the Cirene Project is carried out by 160 researchers and technical men, to whom a further group of 100 persons will be added for the construction of the prototype unit. Unless unexpected difficulties arise, the prototype's criticality should be attained not later than 1971. The nature of the problems connected with this type of plant is described; the research work already done, or in progress, to understand and solve these problems is discussed. (auth)

1811 THE DRAGON PROJECT AND THE USE OF HIGH TEMPERATURE REACTORS. Rennie, C. A. (Atomic Energy Establishment, Winfrith, Eng.). pp 321-32 of Competitivita Conversione e Breeding le Grandi Tappe Dell'Energia Nucleare. Rome, Comitato Nazionale Energia Nucleare, 1967.

From 9th International Meeting on Nuclear Energy, Milan, Dec. 15–17, 1966. See CONF-661213.

The experience gained during the initial operation and at full design power operation of the Dragon Reactor Experiment is reviewed. This experience has established that the basic problems of He technology and of fuel development have been successfully solved. The different fuel cycles which can be used with high temperature reactors are discussed, ranging from the highly enriched U–Th system with recycling of the ^{233}U produced in the reactor to the slightly enriched U system which can be used to produce Pu for fast reactors. The assessment studies for high temperature power reactors which have been carried out and the ways in which such reactors can be used in nuclear power programs are also discussed. (auth)

1812 ADVANCED HIGH TEMPERATURE THERMAL SPECTRUM REACTOR SYSTEMS AND COMMENT ON THE RELATIONSHIP TO FAST BREEDER SYSTEMS. de Hoffmann, F.; Rickard, C. L. (General Atomic, San Diego, Calif.). pp 355-73 of Competitivita Conversione e Breeding le Grandi Tappe Dell'Energia Nucleare. Rome, Comitato Nazionale Energia Nucleare, 1967.

From 9th International Meeting on Nuclear Energy, Milan, Dec. 15–17, 1966. See CONF-661213.

High temperature gas-cooled reactors (HTGRs), graphite moderated, and operating in the thermal neutron spectrum region have made rapid strides. In addition, the application of high temperature gas cooling technology to fast neutron spectrum breeder reactors has been examined. During 1966, the prototype HTGR power plant at Peach Bottom, Pa. was loaded with nuclear fuel, and low power nuclear tests have confirmed the expected behavior. At the same time, both Peach Bottom power station and the Dragon reactor experiment have confirmed much of the design basis for primary circuit components and auxiliary systems. The Peach Bottom power station is presently being readied for full power operation with full power expected in early 1967. Design work and experimental development of components for the 330 MWe HTGR power station for Public Service Company of Colorado are far advanced and designs of HTGR power plants in the 600-1000 MWe range could be examined. Advanced converters of the HTGR type are expected to have capital costs which are comparable to or lower than light water reactors. Fast breeder reactors have to be very good in terms of both capital and fuel cost if they are to compete economically with these advanced thermal reactors of the 1970's. Gas-cooled fast breeder reactors which are capable of breeding ratios as high as 1.55 appear to meet this goal. From a resource conservation point of view, it would appear that high specific power, high conversion ratio advanced reactors of the HTGR type can utilize resources as effectively as current conceptual designs for sodium cooled mixed oxide fueled fast breeder reactors. It would appear from a resource utilization point of view that there is no need for fast breeder reactors at least until the year 2000 and beyond. (auth)

1813 NUCLEAR ENERGY: REALITIES AND PROSPECTS. Salvetti, C. (CNEN, Rome). pp 385-99 of Competitivita Conversione e Breeding le Grandi Tappe Dell'Energia Nucleare. Rome, Comitato Nazionale Energia Nucleare, 1967.

From 9th International Meeting on Nuclear Energy, Milan, Dec. 15–17, 1966. See CONF-661213.

The subsequent development stages of nuclear energy, as well as the most important and promising nuclear programs, both in Italy and abroad are evaluated. (auth)

1814 PREDICTABLE EVOLUTION OF THE ECONOMIC INTEGRATION OF NU CLEAR, CONVENTIONAL THERMAL AND HYDRO-ELECTRIC POWER PLANTS. Angelini, A. M. (ENEL, Rome). pp 401-25 of Competitivita Conversione e Breeding le Grandi Tappe Dell'Energia Nucleare. Rome, Comitato Nazionale Energia Nucleare, 1967.

From 9th International Meeting on Nuclear Energy, Milan, Dec. 15–17, 1966. See CONF-661213.

Atomic energy has crossed the threshold of competitivity thanks to the high-power plants of the tested type that are either under construction, or on the project stage all over the world: it may be safely assumed that the competition between thermal and nuclear stations is making way for a competition among nuclear stations of various types. As regards the situation in Italy, the hydroelectric and economic resources still to be exploited represent only a small percentage of the domestic demand for energy in the decades to come. The amount of electric power from thermal sources will be increasingly higher: the thermal supply will be more and more dependent on nuclear stations, until the latter source of supply will become the prevalent one; as a result, the future role of the conventional thermal stations will be less and less important. The power made available during the night and on weekends, will make the hydroelectric plants with storage of energy by means of a water lifting apparatus, increasingly attractive. The orographic situation in Italy is such that it will be possible to realize a large number of competitive pumping stations; and the gradual decrease in the marginal costs of electric power, resulting from the ever increasing use and advancements of nuclear stations, will be instrumental in making the pumping stations even more convenient, and in promoting their development. (auth)

1815 SEARCH FOR COMMON BASES FOR THE ECONOMIC VALUATION OF CONVERTERS FED WITH HEAVY WATER. Biondi, L. (Montecatini-Edison, Milan). pp 443-55 of Competitivita Conversione e Breeding le Grandi Tappe Dell'Energia Nucleare. Rome, Comitato Nazionale Energia Nucleare, 1967.

From 9th International Meeting on Nuclear Energy, Milan, Dec. 15–17, 1966. See CONF-661213.

A conventional cost calculation for the energy produced by the various types of reactors, free of arbitrary advantage and disadvantage factors for a given concept of plant is given and the problem is analyzed in its various implications. The impossibility of making an exact comparison among the various types of reactors, by referring to a single value of plant power, interest rate of money and hours of utilization, is acknowledged. The comparison can be made only through the comparison of the variations of such costs in relation to the above mentioned values. To offer a prospect and a rational basis to the interest for breeder nuclear reactors, the incidence of the possible variation in the cost of natural uranium should be taken into account in the economic analysis. The setting up of graphs for each plant, indicating the cost of the energy produced in relation to the ratio rate of interest/hours of utilization, and to the cost of natural uranium, is suggested. These graphs will offer the possibility of ascertaining the zones affording the highest or lowest degree of convenience. (auth)

1816 POWER REACTOR TECHNOLOGY AND REACTOR FUEL PROCESSING. Volume 10, Number 1. Dutton, James J.; Lennox, David H.; Brown, Karl K.; Royal, Joseph; Gold, Raymond; Schmeh, Barbara A. A Quarterly Technical Progress Review published for the Division of Technical Information, USAEC. Argonne National Laboratory, Illinois, Winter 1966-67. 92p. GPO $1.00 Domestic, $1.20 Foreign.

Progress on power reactor technology and reactor fuel processing are reported under 11 topics. Separate abstracts were prepared for each topic. (M.C.G.)

For abstracts of individual sections see: 148–152, 1037, and 1817–1821.

1817 FLOW-INDUCED VIBRATION IN REACTOR INTERNALS. Wambsganss, Martin W. Jr. Power Reactor Technol. Reactor Fuel Process., 10: 2-5 (Winter 1966-67).

In general, the theoretical results show that, under idealized conditions, fluid flow may cause self-excited vibration of a suspended blade or amy cause the blade to deflect statically to one side of its normal, centered position. Quantitatively the results do not correlate well with experiment; the discrepancies have been attributed to a failure to take into account the cross flow or flow around the longitudinal edges of the blade. Qualitatively, however, the results do explain the behavior observed in the experimental water-table model. The results suggest measures that may be effective in correcting a vibration problem on a suspended blade or other bodies caused to vibrate by the same phenomenon. However, unless it is clear that only longitudinal flow is significant, testing is still required for a conclusive evaluation of proposed corrective measures. (auth)

1818 THE MOLTEN SALT REACTOR: AN INGREDIENT OF NUCLEAR PROGRESS. Smith, Fred A. Power Reactor Technol. Reactor Fuel Process., 10: 6-16 (Winter 1966-67).

A description of the Molten Salt Reactor Experiment is given. The fuel salt drain tanks, containment cell, reactor vessel, heater tubes, graphite core, access nozzles, heat exchangers, impeller and motor for the vertically mounted centrifugal fuel pump, fuel drain tank, and radiators are generally described. 23 references. (M.L.S.)

1819 TOWARD AN UNDERSTANDING OF SODIUM FIRES. Lottes, Paul A. Power Reactor Technol. Reactor Fuel Process., 10: 17-19 (Winter 1966-67).

Burning rates for large sodium fires with relatively unrestricted access to air are shown. The test apparatus used for these fires is presented. 16 references. (M.L.S.)

1820 TWO-PHASE COMPRESSIBILITY PHENOMENA AND HOW THEY AFFECT REACTOR SAFETY. Fauske, Hans K. Power Reactor Technol. Reactor Fuel Process., 10: 27-31 (Winter 1966-67).

Data on critical flow and acoustic velocity in two-phase compressible mixtures are presented. The relation of these data to safety is discussed. Critical flow measurements are tabulated; flow models are evaluated. Sound velocity models are presented. 30 references. (M.L.S.)

1821 OPERATIONAL DATA FOR POWER REACTORS IN THE UNITED STATES. Schmeh, Barbara A. Power Reactor Technol. Reactor Fuel Process., 10: 32-58 (Winter 1966-67).

Thermal and electrical generating statistics for U. S. power reactors through 1966 are summarized. Included are essentially all reactor facilities that have directly affected development programs concerned with central-station power. Data on annual and total electrical generation, reactor availability, and plant capacity factor (the latter is defined as percent of power the plant did produce as compared with what it would have produced if it operated full time at full power) are given. The principal milestones achieved by central-station plants, and past and projected nuclear electrical generating capacities are presented. Cumulative thermal power generated by 15 utility central-station reactors, 9 experimental reactors, 10 reactor experiments, and 7 military remote-station power reactors are shown. The causes of shutdowns of 5 days or more, which are indicated by numbers on the curves, are explained in the captions. Although the figures do not provide detailed operating information, they do summarize plant operations for a wide variety of reactors. (auth)

1822 HETEROGENEOUS NUCLEAR REACTOR LIQUID MODERATED AND COOLED. Bernard, J. A.; Bunge, J. (to

Communaute Europeenne de l'Energie Atomique–EURATOM), Canadian Patent 756,713. Apr. 11, 1967. Priority date Oct. 3, 1962, Belgium.

The heavy-water moderated organic cooled reactor vessel is divided vertically into two parts. The upper part contains the vertical fuel channels of sintered aluminum with each surrounded by a calandria tube of aluminum or Zircaloy. The lower portion called the "collector compartment" is partially filled with the organic coolant. Nitrogen under pressure is used to circulate the coolant. A heat insulating shield divides the upper and lower compartments. A special expansion joint is described which allows the fuel channels to expand axially without stress. (F.S.A.)

1823 PROCEEDINGS OF THE 1966 CONFERENCE, ATOMIC INDUSTRIAL FORUM, INC., PITTSBURGH, PA., NOVEMBER 1–3, 1966. New York, Atomic Industrial Forum, 1967. 247p. $15.00. (CONF-661108). DTIE.

Discussions include plans and policies of the isotopes program, analysis of uranium supply, the nuclear space program, nuclear energy for public use, fuel cycle economics, marine requirements and nuclear capabilities, and the fast breeder program. (D.C.C.)

1824 SBORNIK PRACI ZAVODU JADERNE ELEKTRARNY OBOROVEHO PODNIKU, SKODA, PLZEN. (Collection of Works on Utilization of Nuclear Power Plants, Skoda, Plzen). Plzen, Czechoslovakia, Skoda Works, Department of Nuclear Power Stations, 1967. 224p.

Topics discussed include: parameter optimization for nuclear power plants; heavy water-moderated reactor stability without mechanically controlled absorbing rods; moving grid reactor control system; optimal margin of systems with regeneration; thermal conduction in support skirts of reactor pressure vessels; high burnup fuel utilization in heavy water-moderated reactors; measurement and design of pipe expansion joints; photoelastic methods for simulating thermal stresses; uranium fuel element failure testing in CO_2; and investigation of gas flow by using Freon. Separate abstracts are presented for the ten papers included. (D.C.C.)

For abstracts of individual papers see: 783, 1825–1831, 1884, and 1885.

1825 OPTIMALIZATION OF PARAMETERS OF AN ATOMIC POWER PLANT WITH PRESCRIBED NET OUTPUT. Mlady, Zdenek; Vyskocil, Vaclav. pp 11–42 of Sbornik Praci Zavodu Jaderne Elektrarny Oboroveho Podniku, Skoda, Plzen. Plzen, Czechoslovakia, Skoda Works, Department of Nuclear Power Stations, 1967. (In Czech).

The technique and results of optimized design variables for a nuclear power station with gas cooled and heavy water moderated reactor operated with natural fuel is given. The optimum values of thermodynamic and physical design variables are obtained on the basis of reaching the minimum value of the economic criterion. The described optimization is compared with the fixed diameter of active core. Results of optimization allow the optimum values of basic design variables and the effects of particular economic and cost relations on the optimization process to be obtained. (auth)

1826 COMPENSATION OF A HEAVY WATER REACTOR WITHOUT MECHANICALLY CONTROLLED ABSORBING RODS. Lnenicka, Bohumil; Wagner, Karel. pp 43–73 of Sbornik Praci Zavodu Jaderne Elektrarny Oboroveho Podniku, Skoda, Plzen. Plzen, Czechoslovakia, Skoda Works, Department of Nuclear Power Stations, 1967. (In Czech).

A reactor shim system without mechanically controlled absorbing rods is described. This served as an aid in choosing the compensating system for the heavy water moderated, gas cooled, natural uranium fuelled reactor. The possibilities of using depleted uranium, burnable poisons, absorbing sheets, moderator voids and hydraulically controlled rods were studied. (auth)

1827 COMPENSATION FOR THE REACTIVITY BY MEANS MOVING GRIDS. Krettova, A.; Valenta, V.; Vlachovsky, K. pp 74–94 of Sbornik Praci Zavodu Jaderne Elektrarny Oboroveho Podniku, Skoda, Plzen. Plzen, Czechoslovakia, Skoda Works, Department of Nuclear Power Stations, 1967. (In Czech).

The possibility of reactivity compensation by means of horizontally placed absorbing grids with the fuel channels being located vertically is presented. The analysis is carried out in two group method for unreflected reactor. The physical characteristics of a system with two and four symmetrically placed and one and two asymmetrically placed shim grids in dependence on their position, absorbing and scattering properties are given. The analysis of reflected systems with flattened active core by means of expanding the neutron flux into orthogonal series is described. The results of the thermal analysis are briefly mentioned which show that the power rating of the reactor and the efficiency of the station can be raised by descripted absorbing grid in the reactor. The results obtained show that this method of the reactivity compensation may be well used in heavy water reactors. (auth)

1828 OPTIMAL MARGIN OF SYSTEMS WITH REGENERATION. Drab, Frantisek. pp 95–103 of Sbornik Praci Zavodu Jaderne Elektrarny Oboroveho Podniku, Skoda, Plzen. Plzen, Czechoslovakia, Skoda Works, Department of Nuclear Power Stations, 1967. (In Czech).

The results of theoretical analysis for reliability of margin systems are presented. The analytical dependencies among the number of systems in margin; frequency of faults, repair time, number of simultaneously repaired systems and the resulting reliability of the system are described. The variable $\xi = \lambda/\nu$ is introduced as a complex characteristic for the reliability of the particular system which respects the fault coefficient of the system λ and ability of regeneration ν. It is shown that the shortening of the mean repair time is equivalent to decreasing the danger of faults. Finally it is shown that the greater the reliability of a particular system, the greater effect the margin of systems has. The method used enables not only to compare the reliability of systems quantitatively but also to design optimal systems of mass attendance and in this way to find optimal compromise between the quality of attendance and financial charges. The results obtained are applied on a reactor control system with moving detectors. (auth)

1829 THERMAL CONDUCTIVITY OF THE SUPPORT SKIRT OF THE NUCLEAR REACTOR PRESSURE VESSEL. Juzova, Z.; Klatil, J.; Kunes, J.; Ulrych, B. pp 104–62 of Sbornik Praci Zavodu Jaderne Elektrarny Oboroveho Podniku, Skoda, Plzen. Plzen, Czechoslovakia, Skoda Works, Department of Nuclear Power Stations, 1967. (In Czech).

A solution of problems connected with determination of steady and unsteady temperature fields in the support skirt of the nuclear reactor pressure vessel is presented. The numerical solution of steady and unsteady temperature fields was carried out on an automatic computer. An analytical solution of steady fields for simplified two dimensional models, an electrolytic tank for solving steady temperature fields, and a continuous R–C analogue for solving unsteady temperature fields are described. (auth)

1830 PRELIMINARY STUDY REGARDING THE FUEL UTILIZATION IN A HEAVY WATER REACTOR AND THE POSSIBILITIES OF OBTAINING HIGH BURN-UP. Jankovec, Petr. pp 163–72 of Sbornik Praci Zavodu Jaderne Elektrarny Oboroveho Podniku, Skoda, Plzen. Plzen, Czechoslovakia, Skoda Works, Department of Nuclear Power Stations, 1967. (In Czech).

The burn-up regime of natural uranium reaching the value of 10,000 MWd/t in one cycle is compared from the point of view of natural uranium utilization with the burn-up regimes of enriched fuel, the various values of which were reached under conditions of infinite number of cycles. The nomograph with some fuel cycle regimes of up to date operated nuclear power stations is given. The computation results of the multiplication coefficient of the uranium-heavy water system is introduced. (auth)

1831 INVESTIGATION OF GAS FLOW BY MEANS OF FREON. Kotrnoch, Josef; Stepanek, Karel. pp 215–23 of Sbornik Praci Zavodu Jaderne Elektrarny Oboroveho Podniku, Skoda, Plzen. Plzen, Czechoslovakia, Skoda Works, Department of Nuclear Power Stations, 1967. (In Czech).

The method of flow analysis by means of Freon is described. A very small quantity of Freon is added to the main flow by means of special probes, and then its concentration is measured (detected) by means of a halogen detector in different points of flow. The method of adding Freon, sampling of mixture and calibrating the halogen detector are described. An example of using this method for the investigation of the mixing of gas in a bundle of parallel rods in axial flow is presented. (auth)

1832 POTENTIAL APPLICATIONS OF FLUIDICS IN NUCLEAR PLANT. Grant, J.; Wright, J. (United Kingdom Atomic Energy Authority, Risley, Eng.). Paper K2 of Second Cranfield Fluidics Conference, 3rd–5th January, 1967. Cambridge.

When designing instrument and control equipment for a reactor the core presents very severe environmental problems. Coolant temperatures in which instruments and mechanisms are to operate exceed 450°C on the Magnox reactors. With the advent of high temperature fuel elements in Advanced Gas Cooled and Fast Reactors coolant temperatures can be raised to 650° to attain the high thermal efficiency of modern steam plant. Adding to the environmental difficulty is the problem of access to core instruments posed by the presence of a pressure vessel surrounding the core. Access is limited and the cost of penetrations for control leads and instruments is high. These problems will become more severe in the future as the coolant temperature and core power densities in reactors increase. Fluidics would appear to offer a solution to some of these problems. The kinetic energy of the coolant flow can be used to power fluidic devices, and the devices themselves can be made of materials which will withstand high temperatures and intense irradiation levels. (auth)

1833 THEORY AND MEASUREMENT OF NEUTRON IMPORTANCE IN NUCLEAR REACTORS. Greenspan, Ehud. Ithaca, N. Y., Cornell Univ., 1966. 202p.

Thesis.

A combined theoretical, calculational, and experimental study of the phase space distribution of neutron importance and other adjoint functions for a nuclear reactor is made. A procedure for modifying transport codes, designed to calculate the neutron density distribution, for adjoint functions calculations is formulated. Following this formulation of multigroup computer codes DOSE-A and PONE-A are prepared in Fortran-63 for the CDC 1604 to calculate the thermal importance function in the S_4 and the consistent P_1 approximations. The thermal importance function fine structure in the Cornell University Critical Assembly (ZPR) lattices is calculated with these codes and employed for computation of unit cell reactivity coefficients, for computation of bilinear weighted thermal group cross sections and for studies of the thermal neutron balance. A significant anisotropy in the importance function distribution is observed for these lattices and the consistent P_1 approximation is not adequate. The reactivity disadvantage factors for 1/v and for energy independent thermal absorbers are found to be smaller than the neutron density disadvantage factor. Bilinear weighting of the thermal group cross sections results in a 2% higher value for Σ_a/Σ_s and in a 0.3% higher value for Σ_f/Σ_a of the 1.5:1 ZPR lattices as compared to flux weighting only. It is also found that the effect of the slowing down sources on the thermal neutron balance can be studied conveniently in the adjoint formulation. Such a study shows that the assumption that the source of thermal neutrons comes from proton collisions only results in an overestimate of ηf by less than 0.1% for the 1.5:1 ZPR lattices. The level of the highest group importance function in the moderator of the unit cell is shown to be a good estimate for ηf. A procedure to maximize ηf by redistribution of the fuel isotopes across the fuel element is developed and a 0.65% increase in the calculated value of ηf is obtained with a variable enrichment fuel rod in the 1.5:1 ZPR lattices. This optimization requires knowledge of both the importance function and the flux fine structure. A procedure for the unit cell homogenization for the purpose of adjoint function calculations is also formulated. Methods for the measurement of the importance function are investigated. Radial and axial traverses of the total neutron importance are measured with a small boron sample for the 1.5:1 ZPR core. Similar traverses of the thermal statistical weight are measured with a small cadmium sample and traverses of the importance of the fission neutrons from spontaneous fissions of a tiny Cf^{252} source are also measured. No substantial difference between the boron and the cadmium measurements is observed. The radial and axial traverses of the Cf^{252} fission neutron importance fit very well to a J_0 Bessel function and to a cosine function, respectively, and give accurate values of the geometric bucklings for the reactor. Few group diffusion theory calculations for the homogenized reactor, when corrected for heterogeneity and spectral effects, agree well with the measured traverses of the reactivity coefficients and of the fission neutron importance. (auth) (Disser. Abstr.)

1834 STEAM SUPERHEATING NUCLEAR REACTOR HAVING STEAM FLOW EQUALIZER. Murdock, Thomas B. (to U. S. Atomic Energy Commission). U. S. Patent 3,354,042. Nov. 21, 1967.

An apparatus for equalizing the flow of steam through a group of steam superheating fuel element assemblies commonly manifolded at their inlets and outlets, and incorporating a region in which condensate may be trapped to cause unequalized flow of steam is described. The condensate trap regions are arranged at a common level and are intercommunicated by manifolding with a conduit or conduit and valve arrangement to equalize the level of condensate among the fuel element assemblies. (AEC)

1835 COMPENSATING FOR REACTIVITY CHANGES IN LIQUID-MODERATED NUCLEAR REACTORS. Dolle, Lucion (to Commissariat a l'Energie Atomique). British Patent 1,087,386. Oct. 18, 1967. Priority date Oct. 13, 1965, France.

A method for compensating for reactivity changes due to fuel depletion and to poison buildup in a liquid-moderated reactor is described. The process described uses heavy water as the moderator and B and Li as the removable poisons. The poisons are combined to form lithium tetraborate in the heavy water. The heavy water is then subjected to continuous purification by passing it through a mixed bed of weak and also strong anionic resins and cationic resins. (D.C.C.)

1836 FUEL CLUSTER FOR NUCLEAR REACTOR. Cousseran, Pierre; Hassig, Jean Marc; Roche, Roland (to Commissariat a l'Energie Atomique). British Patent 1,087,418. Oct. 18, 1967. Priority date July 10, 1964, France.

The design of a fuel cluster assembly for a heterogeneous gas-cooled reactor is presented. The assembly is made of a plurality of parallel fuel elements which are cylindrical rods enclosed in finned cans. The fins extend axially along the full length of the fuel element and are arranged to form pairs with fins from adjacent fuel elements. The fins are joined by keys which are removable by an axial slide from the keyways provided in the joined fins. (D.C.C.)

1837 IMPROVEMENTS RELATING TO PRESSURE VESSELS FOR NUCLEAR REACTORS. Norgrove, Royal Malcolm (to Fairey Engineering Ltd.). British Patent 1,087,732. Oct. 18, 1967. Filed May 16, 1963.

The design of a pressure vessel for a graphite-moderated reactor is presented. The heating and cooling channels for gas flow through the graphite moderator are designed to reduce the number of entrance and exit pipes in the pressure vessel. (D.C.C.)

1838 NUCLEAR REACTOR PLANTS. (to Sulzer Brothers Ltd.). British Patent 1,087,520. Oct. 18, 1967. Priority date Sept. 24, 1965, Switzerland.

The design of circulator blowers arranged in parallel to circulate a gaseous coolant in a closed cycle through a reactor and a heat exchanger is described. Each blower has a radial diffuser with stationary vanes and flaps which are opened by coolant flow from the blowers and closed when coolant flow fails. (D.C.C.)

1839 NUCLEAR REACTOR. Stacey, John; Riley, Peter Liptrot; Parker, Horace Frank (to United Kingdom Atomic Energy Authority). British Patent 1,087,866). Oct. 18, 1967. Filed June 25, 1963.

The design of a fuel element support system for fast reactors is presented. The support system consists of a platform above the core with rigid struts connecting the fuel elements to the platform. Coolant flow from beneath the fuel platform forms a compressive force in holding the fuel elements against the struts. (D.C.C.)

1840 CANNING FOR A NUCLEAR FUEL ELEMENT. Boudouresque, Bernard; Caillat, Roger; Darras, Raymond; Salesse, Marc (to Commissariat a l'Energie Atomique). British Patent 1,087,497. Oct. 18, 1967. Priority date May 26, 1964, France.

The design of Mg–Zr alloy fuel cans for gas-cooled reactors is presented. The fuel can with Zr content less than 1% by weight can be used with carbon dioxide coolant temperatures of about 500°C. (D.C.C.)

Marine and Portable Power Reactors

Refer also to abstract 213.

1841 (CONF-661011, pp 173-99) FABRICATION OF THE SM-1A CORE III. Type-3 Design. Frank, Louis (Hittman Associates, Inc., Baltimore, Md.).

The fabrication of Stationary and Moveable Fuel Assemblies as part of a replacement core for the SM-1A reactor is described. The core is designated Core III (Type 3 design). These assemblies were procured to a product type specification. Fabrication liaison and in-plant inspection by the AEC and their core support contractor are reported. Included are a general core description, materials and product requirements, fabrication processes, and test and quality control results. (J.C.W.)

Rocket and Space Reactors

Refer also to abstracts 655 and 656.

1842 (N-67-17520) REPORT ON THE DESIGN REQUIREMENTS FOR REACTOR POWER SYSTEMS FOR MANNED EARTH ORBITAL APPLICATIONS. Final Report. (Douglas Aircraft Co., Inc., Huntington Beach, Calif. Missile and Space Systems Div.). Jan. 1967. Contract NAS1-5547. 254p. (NASA-CR-66254; DAC-57950). CFSTI.

Results of an assessment of the design requirements are presented. The purpose of the study was to determine those reactor power system concepts that could meet effectively the constantly increasing power demands for Orbital Research Laboratory (ORL) missions and beyond, and satisfy a postulated 1974 to 1977 launch date. Integration of reactor power systems with a manned Earth-orbital space station, using the Manned Orbital Research Laboratory (MORL) concept as an example, has resulted in definition of ORL reactor power system combinations useful at 10-, 20-, and 30-kW(e) power levels, and the pertinent conclusions and recommendations on design of both the reactor power systems and the overall mission and space vehicles. Study objectives were satisfied by a systematic design analysis and integration of five basic reactor-power conversion concepts, including the SNAP-8-type reactor in combination with the SNAP-8 and SNAP-2 mercury Rankine, Brayton, and the direct radiating and compact converter thermoelectric systems. It is concluded that all of the reactor

power systems investigated can be effectively integrated with the MORL to satisfy all laboratory functions and mission objectives, and to provide potential for increased capability and growth accommodation in the laboratory. (STAR)

1843 NUCLEAR SUBSYSTEM CONTROLS FOR THE NERVA EXPERIMENTAL ENGINE. Crews, Roy E.; Hohmann, Garold L. (Westinghouse Astronuclear Lab., Pittsburgh). Nucl. Appl., 3: 653-8(Nov. 1967).

The NERVA Experimental Engine (XE) will be ground tested in a test stand at the Nuclear Rocket Development Station, Jackass Flats, Nevada. The nuclear reactor and its associated controls and instrumentation comprise the XE Nuclear Subsystem, a major engine component. The controls and instrumentation portion of the subsystem is described and its functions delineated. Principal controllers for power and temperature were developed from earlier models used in the testing of KIWI reactors. Controllers for automatic startup and override were later developments for use with NERVA Control. Other portions of the subsystem include nuclear instrumentation, a safety system, and diagnostic instrumentation. 8 references. (auth)

1844 LIMITERS IN NERVA REACTOR CONTROL. Hohmann, G. L.; Walsh, J. M.; Honka, E. K. (Westinghouse Astronuclear Lab., Pittsburgh). Nucl. Appl., 3: 659-64(Nov. 1967).

Limiter circuits, which override spurious signals from normal control circuits, operate when their inputs (e.g., power or temperature) exceed predetermined setpoints. Initially conceived as a necessity for nuclear rocket flight systems, they have been developed successfully and have been shown to be advantageous for ground test systems also. Thus, they maintain vital reactor parameters within acceptable limits, allowing the reactor to operate while the difficulty is being attacked. (auth)

1845 OPTIMAL SPACE TRAJECTORIES OF NUCLEAR ROCKETS. Frik, M.; Kolbe, O. (Univ., Stuttgart). Atompraxis, 13: 400-3(1967). (In German).

A short survey of the difficulties arising from evaluation and realization of fuel optimal space trajectories is given. Nuclear rockets of different propulsion control types are considered. (auth)

Research and Test Reactors and Critical Assemblies

Refer also to abstracts 5, 280, 603, 632, 726, 727, and 748.

1846 (BNWL-SA-1388, pp 1.1-15) FAST FLUX TEST FACILITY. Condotta, D. L. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

The Fast Flux Test Facility is described including its uses, design features, and proposed physical layout. As a complementary facility, the FFTF plans include a Nuclear Proof Test Facility for performing critical experiments. The Fast Test Reactor utilizes a split core array of closed test loops and driver fuel, test, control, and reflector assemblies. Plans are described for an irradiation facility that encloses the fuel handling area and the fuel handling machine. FTR neutronics parameters are tabulated. (J.C.W.)

1847 (BNWL-SA-1388, pp 2.1-13) FUEL SUBASSEMBLY DESIGN DESCRIPTION. Cohn, P. D. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

The fuel subassembly design of the Fast Flux Test Facility is given and the mechanical performance data required are tabulated. A detailed design of the fuel pin is given and performance characteristics of the depleted UO_2 pellets, end fittings, spring and washers, and the internal plenum sleeve are tabulated. Additional fuel form, exposure, and cycle data are given. (J.C.W.)

1848 (BNWL-SA-1388, pp 3.1-41) PROVISIONAL PRODUCT DESCRIPTIONS. Powers, H. G. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

Fifteen provisional product descriptions represent the start of development of FTR driver fuel product specifications. The general structure of the product descriptions concern scope, basis, references, technical requirements of product, test and inspection requirements, lotting requirements, preproduction qualification, material disposition, and submitted requirements. The technical, test, and inspection requirements for the fuel pin assembly are summarized. Submittal procedures are described. Detailed product descriptions of the UO_2-PuO_2 fuel pellets, fuel pins, and driver fuel cladding are included. (J.C.W.)

1849 (BNWL-SA-1388, pp 4.1-5) CLADDING AND HARDWARE CONSIDERATIONS. Lobsinger, R. J. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

The fuel pin consists of cladding, end-caps, plenum tube, plenum spring, Ni reflectors, and the UO_2-PuO_2 fuel. The end-caps and the cladding isolate the fuel from the coolant and are subjected to extreme stress, irradiation, and potential corrosion. The specifications necessary for the fabrication of the end-caps and cladding are discussed. (J.C.W.)

1850 (BNWL-SA-1388, pp 5.1-8) FUEL REQUIREMENTS THROUGH 1980 FOR FFTF FUEL DEVELOPMENT, FTR INITIAL CORE, AND NPTF FUEL. Bardsley, R. E. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

Fuel enrichment and isotopic composition are discussed. A summary of the Fast Test Reactor and Nuclear Proof Test Facility fuel core requirements are tabulated. (J.C.W.)

1851 (BNWL-SA-1388, Suppl.) ROLE OF FFTF PROJECT IN COMMERCIAL LMFBR FUEL FABRICATION. Roake, W. E. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). 8p.

The anticipated amount of nondefense Pu reprocessed is graphically presented. The correlation of the Fast Flux Test Facility and the Liquid-Metal Fast Breeder Reactor Programs are given. (J.C.W.)

1852 (BNWL-SA-1388, pp 7.1-8) FFTF PRODUCT ASSURANCE. Squires, R. J. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

Requirements for the management of reliability and quality assurance activities have been prepared. (J.C.W.)

1853 (BNWL-SA-1388, pp 8.1-7) FFTF CERTIFICATION PROCEDURES. Burgess, C. A. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

The methods and approaches involved in certifying fuel suppliers are discussed. The major considerations are process, product, and service. (J.C.W.)

1854 (BNWL-SA-1388, pp 9.1-6) NONDESTRUCTIVE TESTING. Zeutschel, M. F. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

The major types of nondestructive testing for the Fast Flux Testing Facility fuels are the eddy current sheath tubing tests and the ultrasonic weld test. A scanning test utilizing a pulse analyzer to determine radial and axial fuel pellet homogeneity and total enrichment level of a loaded fuel pin is used. (J.C.W.)

1855 (CEND-115) NUSU CRITICAL EXPERIMENTS. PART I. EXPERIMENTAL DATA FOR UO_2 ROD TYPE CORES EMPLOYING NON-UNIFORM BOILER AND UNIFORM SUPERHEAT REGIONS. Harding, R. S. (Combustion Engineering, Inc., Windsor, Conn. Nuclear Div.). Dec. 29, 1960. Contract AT(11-1)-795. 77p. Dep. CFSTI.

Criticality and power distribution measurements were made in a variety of cores employing solid rod type fuel elements. Data were obtained for comparison with the present day nuclear theory and design techniques as applied to a boiling water reactor with integral nuclear superheat. Three types of basic configurations were investigated in both the cold clean and poisoned state; boiler, boiler plus internal and boiler plus external superheat regions. The data consists of the water height necessary to maintain a critical configuration when all movable control rods were removed and power distributions as measured by the relative fission product gamma ray activities present in the fuel elements. Data are also presented on the change in critical water height due to voiding or flooding of the steam annulus surrounding each superheater fuel element. (auth)

1856 (EUR-3626e) DEVELOPMENT AND IN-PILE PERFORMANCE OF SOME BR2 IRRADIATION RIGS. von der Hardt, P. (Centre d'Etude de l'Energie Nucleaire, Mol (Belgium)). Aug. 1, 1967. 50p. Dep.

The high-flux materials testing reactor BR2 in Mol (Belgium) can satisfy a very large number of experimental requirements due to its conception, and especially its compact core design and to the easy handling of its testing equipment. The development of some of the capsule type irradiation devices (rigs) built for BR2 and irradiated in the period between 1965 and 1967 is described. Most of the work described has been performed and/or coordinated by the CEN Technology Department. (auth)

1857 (GEMP-560) PBF CRITICAL EXPERIMENT CONTROL ROD MEASUREMENTS. Kunze, J. F.; Sims, F. L.; Wood, R. E. (General Electric Co., Idaho Falls, Idaho. Nuclear Materials and Propulsion Operation). Oct. 10, 1967. Contract AT(40-1)-2847. 37p. Dep. CFSTI.

The data and related information associated with control rod measurements conducted with the Power Burst Facility (PBF) Critical Experiment reactor system are presented. The data includes the critical water levels, incremental water worths,

pulsed neutron generator results related to the various core geometries and control rod configurations. These results provide the means by which the control worths are determined. (auth)

1858 (JAERI-1141) CONSTRUCTION OF JRR-4. (Japan Atomic Energy Research Inst., Tokyo). May 1967. 35p. (In Japanese). Dep.

Japan Research Reactor-4 (JRR-4) is a swimming pool type reactor, 1,000 kW in thermal power, with light water as the coolant and moderator. The fuel elements consist of plates of an alloy of 90% enriched ^{235}U and Al. The JRR-4 is installed as the fifth reactor in Japan Atomic Energy Research Institute, and intended mainly for the study of shielding. The JRR-4 is now in operation for the mock-up-tests of shielding of the first nuclear ship. The process of construction of the JRR-4, including the policy of installation and actual construction done, is presented. (auth)

1859 (KFK-592) UNTERSUCHUNGEN AN DER LADUNG 2 DES SCHNELL-THERMISCHEN ARGONAUT-REAKTORS STARK. (Investigation on Charge 2 of the Fast Thermal Argonaut Reactor STARK). Barleon, L.; Bayer, A.; Brueckner, Chr.; Burkart, K.; Kuhn, D.; Kussmaul, G.; Meister, H.; Stegemann, D. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Neutronenphysik und Reaktortechnik). June 1967. 92p. (In German). Dep.

A description of the second core loading of the fast-thermal reactor STARK is given. Critical experiments, flux and power distribution measurements, spectral measurements in the fast zone, reactivity measurements in the fast and thermal zones, and kinetic measurements using the pulse methods are discussed. Results are presented graphically, and are discussed at length. Multigroup calculations are described. (M.L.S.)

1860 (ORNL-4149) ANALYSIS OF NEUTRON FLUCTUATION SPECTRA IN THE OAK RIDGE RESEARCH REACTOR AND THE HIGH FLUX ISOTOPE REACTOR. Robinson, J. C. (Oak Ridge National Lab., Tenn.). Oct. 1967. Contract W-7405-eng-26. 45p. Dep. CFSTI.

An analytical model which accounted for distributed effects on reactivity due to the coolant and heat transport time was developed to aid in the study of the power spectral density of fluctuating current from a neutron-sensitive ionization chamber in the Oak Ridge Research Reactor (ORR) and the High Flux Isotope Reactor (HFIR). Results from the model led to the conclusion that feedback effects on the power spectral density (for these reactors) are small over the frequency range of observation. A comparison of the observed spectra (when properly normalized) at various power levels verified the analytical predictions; therefore, it was concluded that the observed spectra were induced by a reactivity driving function(s) which was independent of the power level. From a comparison of the observed spectra from the HFIR during the life of a given core, it was concluded that the principal driving function was fluctuation of the control rods, which was assumed to be induced by coolant flow fluctuations. Furthermore, we observed that the control rods exhibited resonances at certain positions. Spectra from the ORR at various rod positions were compared. It was concluded that rod vibrations and fuel element vibrations were the driving functions. From spectra obtained at various coolant flow rates, it was clear that these vibrations were induced by fluctuations in the coolant velocity. (auth)

1861 (TID-24098) RESEARCH IN REACTOR CORE PHYSICS UTILIZING PULSED AND STEADY-STATE NEUTRONS FROM A 250 KV COCKCROFT-WALTON ACCELERATOR. Annual Summary Report, September 1964-August 1965. Robeson, Andrew (Virginia Polytechnic Inst., Blacksburg. Dept. of Physics). Dec. 1965. Contract AT(40-1)-2686. 21p. Dep. CFSTI.

The relationship between the eigenfunction expansion method and transform method of solution to the transport equation in slab geometry is discussed. A description of the transformation technique as applied to a slab with anisotropic scattering is given. Application of the transform technique to energy dependent problems is postulated. Measurements of Th resonances are detailed; diffusion parameter measurements for mixtures of light and heavy water at several temperatures are discussed. (17 references). (M.L.S.)

1862 (JPRS-42322) CRITICAL PARAMETERS OF FISSIONABLE MATERIALS SYSTEMS AND NUCLEAR SAFETY (A HANDBOOK). Dubovskii, B. G.; Kamaev, A. V.; Kuznetsov, F. M.; (and others). Translated from pp 1-226 of Kriticheskie Parametry Sistem s Delyashchimisya Veshchestvami i Yadernaya Bezopasnost', Atomic Publishing House, Moscow. 1966. 173p. (TT-67-32951). CFSTI.

Translations are presented for four articles on criticality and nuclear safety. Titles of the articles are: (1) Basic Concepts of Nuclear Safety, (2) Methods of Designing Homogeneous Reactors, (3) Criticality of Systems of Interacting Subcritical Assemblies of Fissile Materials, and (4) Basic Norms for Ensuring Nuclear Safety. Separate abstracts were prepared for each of the four articles. (H.D.R.)

For abstracts of individual articles see: 1863-1866.

1863 (JPRS-42322, pp 1-13) BASIC CONCEPTS OF NUCLEAR SAFETY. Translated from pp 5-14 of Kriticheskie Parametry Sistem s Delyashchimisya Veshchestvami i Yadernaya Bezopasnost'.

The concept of criticality and the factors affecting the criticality of heterogeneous and homogeneous systems are discussed. Some properties of fissile materials in the metallic state and as compounds or mixtures are presented, and the general principles for providing nuclear safety during the processing of fissionable substances are discussed. (H.D.R.)

1864 (JPRS-42322, pp 14-101) METHODS OF DESIGNING HOMOGENEOUS REACTORS. Translated from pp 88-141 of Kriticheskie Parametry Sistem s Delyashchimisya Veshchestvami i Yadernaya Bezopasnost'.

Two approaches to solving the tasks connected with designing uranium-aqueous reactors are examined. The multigroup approximation method is based on a knowledge of the basic parameters of the fuel core of a reactor and the length of neutron moderation. They are generally determined by processing experimental material and then theoretically generalizing it into a concrete class of tasks. The critical mass or the effective multiplication factor is determined by a specially formulated equation of criticality. The second approach is based on the application of sequentially exact hypotheses and mathematical algorithms, which requires only elementary physical constants as additional information. (H.D.R.)

1865 (JPRS-42322, pp 102-57) CRITICALITY OF SYSTEMS OF INTERACTING SUBCRITICAL ASSEMBLIES OF FISSIONABLE MATERIALS. Translated from pp 169-201 of Kriticheskie Parametry Sistem s Delyashchimisya Veshchestavami i Yadernaya Bezopasnost'.

Semi-empirical methods for evaluating the nuclear safety of a system of interacting subcritical assemblies are examined. The methods discussed are: (1) the equivalent dimensions method, (2) the method of the safe solid angle, (3) the interaction parameter method, and (4) the homogenization method. A summary of published experimental data is also presented. (H.D.R.)

1866 (JPRS-42322, pp 158-73) BASIC NORMS FOR ENSURING NUCLEAR SAFETY. Translated from pp 214-22 of Kriticheskie Parametry Sistem s Delyashchimisya Veshchestvami i Yadernaya Bezopasnost'.

Presented are generalizations on the determination of maximum permissible charges and volumes of fissile materials and the determination of safe dimensions and distances between systems. Tabulated data are given for the basic norms for isolated systems, interacting assemblies, and the intersection of pipes carrying solutions of fissile materials. (H.D.R.)

1867 (ORNL-tr-1786) FAST FUEL ELEMENT TESTING REACTOR (P.E.C.). PRELIMINARY DESIGN STUDY. Section I. Aiello, P.; Amadesi, P.; Azzoni, P.; (and others) (Comitato Nazionale per l'Energia Nucleare, Bologna (Italy)). Translated for Oak Ridge National Lab., Tenn., from Sect. 1 of ARV-66-45. 60p. Dep. CFSTI. JCL $6.60 fs, $2.12 mf.

The preliminary design study for the Fast Fuel Element Testing Reactor (P.E.C.) is presented, and topics discussed include: irradiation facilities; reactor core; containment vessel; shielding; cooling system; fuels; and instrumentation. (D.C.C.)

1868 EXPERIMENTAL ANALYSIS OF ENERGY SPECTRUM PARAMETERS IN SLIGHTLY ENRICHED UO_2-H_2O LATTICES. Kobayashi, Setsuo; Kikuchi, Hiroshi; Matsuoka, Kenichi (Hitachi Ltd., Kawasaki, Japan). J. Nucl. Sci. Technol. (Tokyo), 4: 451-61 (Sept. 1967).

The relative neutron temperature represented by the activation ratio (AR) of Lu-Cu and the modified epithermal index in the form $r\sqrt{T_n/T_0}(T_0 = 20°C)$ were measured by foil activation for a wide range of water-to-fuel volume ratios, in slightly enriched UO_2-H_2O lattices. With tight lattices, the values of the activation ratio thus experimentally determined agree better with the two dimensional collision probability calculation than with the one dimensional cylindricalized cell calculation. The values of $r\sqrt{T_n/T_0}$ measured with the use of Au-Mn-Ni alloy foil without Cd-filter are in good agreement with the results calculated by the extended TEMPEST code. 18 references. (auth)

1869 MEASUREMENT OF PROMPT NEUTRON DECAY CONSTANT IN DELAYED CRITICAL STATE OF HEAVILY REFLECTED REACTOR. Kaneko, Yoshihiko (Japan Atomic Energy Research Inst., Ibaraki); Akino, Fujiyoshi; Kurokawa, Ryosuke; Sumita, Kenji. J. Nucl. Sci. Technol. (Tokyo), 4: 462-7 (Sept. 1967).

The measurements of α_c, the prompt neutron decay constant at delayed critical, have been made by pulsed neutron technique in various core configurations of SHE, a graphite-moderated 20% enriched uranium critical assembly. It was confirmed from the results that the value of α_c is very strongly dependent on geometrical configurations of the reflector rather than on the atomic ratio of carbon to ^{235}U in the core region. These results are in fairly good agreement with the calculated values obtained directly as the eigenvalue of the characteristic equation on a 34 group P-1 model. (auth)

1870 MECHANICAL AND THERMAL PROBLEMS IN THE STARTUP OF RAPSODIE. Reynes, Louis. Ind. At., 11: No. 7–8, 35-41(1967). (In French).

The use of Na as a coolant allows the production function of a reactor, which utilizes the high temperature to be utilized. Beyond about 500°C the required temperature becomes the principal parameter of the problem of design and operation. Certain difficulties which come unexpectedly in the course of startup of Rapsodie are presented. (tr-auth)

1871 PHYSICAL MEASUREMENTS TAKEN DURING STARTUP OF RAPSODIE. Gourdon, Jean; Stevens, Lesli. Ind. At., 11: No. 7–8, 41-50(1967). (In French).

Criticality measurements during the approach-to-power of Rapsodie are discussed. Power determinations and measurements of fission ratios for ^{239}Pu and ^{235}U are tabulated. Control rod calibration is shown. Dynamic reactor measurements are discussed. (M.L.S.)

1872 THERMAL MEASUREMENTS TAKEN DURING STARTUP OF RAPSODIE. Giraud, Bernard; Nicol, Gerard. Ind. At., 11: No. 7–8, 51-9(1967). (In French).

Schematics of the primary coolant circuits of Rapsodie are shown. Circuit heat balances are discussed. The in-core instrumentation for thermodynamic measurements is presented; data collection and treatment are discussed. Measured and calculated values are discussed. (M.L.S.)

1873 STUDIES OF THE RATIO OF ^{238}U CAPTURE AND ^{235}U FISSION CROSS SECTIONS IN THE FAST REACTOR FR-O. Tiren, L. I. (Aktiebolaget Atomenergi, Studsvik, Sweden). Nukleonik, 10: 141-8(1967).

Measurements of the ratio of ^{238}U capture and ^{235}U fission cross sections have been made in five cores of the fast zero energy reactor FR-O, corresponding to three substantially different neutron spectra. The experimental results were calibrated by measurements in a thermal spectrum, for which the cross sections involved are accurately known. The capture rate in ^{238}U was detected by counting the ^{239}Np γ-activity of irradiated foils using the γ-X-ray coincidence technique, and the fission ratio in ^{235}U was obtained from the counting rate of a small fission chamber. The experimental results were reproducible to within about 1%. Systematic errors due to the heterogeneous core loadings and other effects add another 1 to 2% to the net uncertainties. The measured values obtained at the centers of the cores are in good agreement with results of multigroup calculations. (auth)

1874 CONCERNING THE ANALYSIS OF SINGLE CHANNEL SUBSTITUTION MEASUREMENTS. Askew, J. R.; Pitcher, H. H. W. (Atomic Energy Establishment, Winfrith, Eng.). J. Brit. Nucl. Energy Soc., 6: 260-70(July 1967).

A method is described for calculating the flux perturbation due to introducing a single full-length fuel element into a possibly dissimilar reactor environment. From this the reactivity perturbation of the reactor may be calculated and compared with experimental determinations. The method is integrated with the WIMS code used for ordinary lattice calculations and uses the same data library. A series of U and Pu/U metal rod substitution measurements performed in the HECTOR reactor is re-analyzed, and the results are shown to be consistent with those obtained in exponential experiments on the same fuel. (UK)

1875 AN EXPERIMENTAL COMPARISON OF THE FAST AND THERMAL NEUTRON BUCKLINGS IN A URANIUM DIOXIDE LIGHT-WATER MODERATED CRITICAL ASSEMBLY. Shaw, Robert Alexander. Ithaca, N. Y., Cornell Univ., 1967. 64p. Thesis.

A comparison of the spatially dependent fast and thermal neutron flux profiles has been made in the Cornell University Zero Power Reactor, a light-water moderated and reflected, 2.1% enriched, UO_2 fueled, aluminum clad, triangular pitched critical assembly, using the core which has a nominal water-to-fuel ratio of 1.5 : 1. The radial buckling, defined by a least-squares fit of the radial flux profile to a J_o Bessel function, is chosen as a convenient single-parameter characterization of the profile for comparison of flux profiles. The radial fast flux profile was determined by using a semiconductor detector to detect fission fragments from the fast fissioning of Th-232. The radial thermal flux was determined by the irradiation of manganese foils. The bucklings are found as a function of the radial distance (r) from the core center by performing the least-squares fit on data taken from the core center out to r. The thermal neutron reflector hump causes the thermal flux to deviate significantly from the J_o dependence for r greater than about two-thirds of the core radius. Considering the region in which the thermal flux generally follows a J_o dependence, the ratio of the thermal buckling to the fast buckling is found to be $1.131 \pm .052$ and $1.076 \pm .052$ for the two largest values of r in this region for which the bucklings are calculated. An analysis of theoretical fast and thermal flux profiles for this core which were calculated independently of this work supports the conclusion that the ratio of the thermal buckling to the fast buckling is greater than one. However, a precise comparison is not valid because the fast flux was theoretically calculated for neutrons in the energy range between 0.821 MeV and 10.0 MeV whereas the effective fission threshold for Th-232, used to experimentally determine the fast flux, is about 1.35 MeV. (Disser. Abstr.)

1876 EXPERIMENTAL LOOP FOR NUCLEAR REACTOR. Gumuchian, A. (to Indatom S.A.R.L.). Canadian Patent 757,720. Apr. 25, 1967. Priority date Jan. 18, 1962, France.

The cylindrical portion of the loop within the reactor core is designed so that it may be rotated through 180°. Materials intended for radiation exposure are situated on a diameter of the cylinder near the periphery and separated by a considerable layer of a neutron absorbing substance. Thus, to remove a material under test from the radiation field it is only necessary to rotate the cylinder. Cooling is uninterrupted and the space in the reactor is not left empty. (F.S.A.)

Production Reactors

Refer also to abstract 1915.

1877 SEED-BLANKET CONVERTER-RECYCLE BREEDER REACTOR. Raab, H. F. Jr.; Galper, M. J.; Jones, D. H.; Conley, G. H.; Hannum, W. H. (to U. S. Atomic Energy Commission). U. S. Patent 3,351,532. Nov. 7, 1967.

A thermal breeder neutronic reactor having uranium-233 fuel, a thorium-232 blanket and light water coolant with an average hydrogen to thorium-232 ratio of 0.4 to 1.5 is described. (AEC)

Reactor Theory, Components, Fuels, and Accessories

Refer also to abstracts 24, 202, 217, 283, 304, 390, 400, 612–614, 633, 634, 641, 642, 645, 724, 725, 732, 734, 738, 744, 745, 765, 768, 771, 773, and 774.

1878 (ANL-7307) MONTE CARLO ANALYSIS OF REACTIVITY COEFFICIENTS IN FAST REACTORS; GENERAL THEORY AND APPLICATIONS. Miller, Laurence B. (Argonne National Lab., Ill.). Mar. 1967. Contract W-31-109-eng-38. 83p. Dep. CFSTI.

Thesis.

A mathematical formulation for solving the space- and energy-dependent Boltzmann equation by indirect analogy is developed. This is done by using a stochastic analysis to estimate probabilities for space transport. Effects of variation of fuel element diameter on the Doppler coefficient are considered. A fractional interaction model is set up. Evaluation of the integral equation resulting from the source term is obviated by using a weighted starting source chosen from the normalized distribution. A computer code, Argonne Monte Carlo (AMC), which determines the absorption probability and statistical error is constructed from these equations. The program is discussed. A verification of theory is made from critical assembly experiments. 101 references. (M.L.S.)

1879 (EUR-3623f) INVESTIGATIONS POUR LE CALCUL DU RELACHEMENT DE PRODUITS DE FISSION DES ELEMENTS COMBUSTIBLES IRRADIES EN VUE DE LEUR TRANSPORT. PARTIE I. (Investigations for the Calculation of the Fission-Product Release From Irradiated Fuel Elements with a View to the Transport Thereof. Part I). Crostini, R.; Rossi A. (Societa Ricerche Impianti Nucleari, Saluggia (Italy). Centro Ricerche Nucleari). June 22, 1967. 69p. (In French). Dep.

Topics discussed include: the IAEA regulation on the transportation of irradiated fissile materials; bibliographic analysis of the properties of fissile and cladding materials, test calculations of fission product release under normal transportation conditions and after a thermal accident during transportation; a general analysis of measures which would answer some of the existing questions; and proposals for concrete research on the release of fission products by irradiated fuel elements. (auth)

1880 (IN-1113) BURNUP DETERMINATION OF NUCLEAR FUELS. Project Report for the Quarter, October 1–December 31, 1966. Lisman, Frederick L.; Maeck, William J.; Rein, James E. (eds.) (Idaho Nuclear Corp., Idaho Falls). Oct. 1967. Contract AT(10-1)-1230. 49p. Dep. CFSTI.

The measurements of the absolute, thermal fission yields of stable Cs-133, 30.3y Cs-137 and the stable Zr-91, -92, -93, -94, and -96 isotopes for U-233 and U-235 by isotope dilution mass spectrometry are presented. (auth)

1881 (KAPL-P-3381) BUCKLING ANALYSIS OF REACTOR CORES. PART 6. THE METHOD OF SOLUTION-FUNCTIONS EXTENDED FROM $\rho-\theta$ TO $\rho-\phi$ AND $\rho-\theta-\phi$ CYLINDRICAL GEOMETRIES. Bobone, Renato (Knolls Atomic Power Lab., Schenectady, N. Y.). Jan. 3, 1967. Contract W-31-109-eng-52. 18p. (CONF-671102-23). Dep. CFSTI.

From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill.

A method of computerized solution to the one-group diffusion equation for multiregion reactors in $\rho-\zeta$ geometry and $\rho-\theta-\zeta$ geometry is given. Neutron flux calculations are shown as a function of reactor core radius. (M.L.S.)

1882 (KAPL-P-3392) TIME SYNTHESIS: A STUDY OF SYNTHESIS MODES AND WEIGHTING FUNCTIONS. Rydin, Roger A. (Knolls Atomic Power Lab., Schenectady, N. Y.). Nov. 7, 1967. Contract W-31-109-eng-52. 25p. (CONF-671102-31). Dep. CFSTI.

From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill.

The Time-Synthesis Method has been used to investigate the effects of the choice of trial functions and weighting functions on the results of synthesis calculations. It was found that the time-dependent total power in a reactor could be adequately predicted using any of the methods of weighting considered (region-balance, flux, or adjoint), but that the spatial flux distribution was more difficult to synthesize. In particular, region-balance weighting did not give very good spatial results, flux weighting gave better results which were sensitive to the group spectra, and adjoint weighting gave the best results. A singularity in the total removal matrix was observed during the course of the transient in one of the adjoint weighted problems. The synthesis results were sensitive to the choice and number of trial functions used. In particular, the asymptotic flux shape, corresponding to the final state of the reactor, was not the best mode to use because of delayed neutron holdback effects. Similarly, the addition of transition modes between the initial and final states were beneficial in improving the time-dependent flux shapes calculated early in the transient. Qualitative criteria were developed for choosing synthesis modes based upon the initial eigenvalue separation of the core, the time scale of the transient relative to the delayed neutron half-lives, and the total magnitude of the perturbation. (auth)

1883 (ANL-Trans-523) ANALYSIS OF NUCLEAR FUELS. Motojima, K.; Hashitani, H.; Yamamoto, T. Translated by Elmar K. Wilip (Argonne National Lab., Ill.), from report KFK-tr-207. 17p. Dep. CFSTI. JCL $1.60 fs, $0.80 mf.

Also appears in Bunseki Kagaku, 14: 190R-8R(1965).

Au analysis of the mechanisms of ^{239}Pu production and use as reactor fuels is discussed. The various methods for recovery of ^{239}Pu from uranium fuels and ores is outlined. Determination of impurities and admixtures in plutonium is discussed briefly. 333 references. (M.L.S.)

1884 MEASUREMENT AND DESIGN OF THE PIPE EXPANSION JOINTS. Sneberger, J.; Polachova, H. pp 173-89 of Sbornik Praci Zavodu Jaderne Elektrarny Oboroveho Podniku, Skoda, Plzen. Plzen, Czechoslovakia, Skoda Works, Department of Nuclear Power Stations, 1967. (In Czech).

The results of strength tests for three types of pipe expansion joints are presented. The experimental results for the thoroid compensator are matched with theoretical calculation done by the method of asymptotic integration according to Tumarkin and numerical integration according to Hampl. (auth)

1885 THE DETECTION OF THE FAILING OF URANIUM FUEL ELEMENT AT THE NON-ACTIVE TESTS IN THE FLOW OF CO_2. Zajic, Vladimir; Vlcek, Jiri; Hudecek, Milan. pp 203-14 of Sbornik Praci Zavodu Jaderne Elektrarny Oboroveho Podniku, Skoda, Plzen. Plzen, Czechoslovakia, Skoda Works, Department of Nuclear Power Stations, 1967. (In Czech).

A radiometric method of detection of U in the test non-active circuit with the wire fuel element and the way of a practical application is described. The growth of the U concentration in the circuit is the function of the destruction of fuel element, of the escape of aerosol from the circuit and of its possible ground in parts of test loop. The practical experiences with the application of the described method has certified the reliability of the beginning tested fuel element failure. The method of radiometric detection of U in the test circuit is extraordinarily sensitive in comparison to some methods of chemical analysis. (auth)

1886 THERMODYNAMIC ADVANTAGES OF FUEL ELEMENTS WITH VARIABLE EFFICIENT HEAT EXCHANGE. Simonek, Jiri (State Research Mechanical Inst., Bechovice, Czech). Jad. Energ., 13: 361-5(Oct. 1967). (In Czech).

A thermal analysis was made of nuclear reactor fuel cooling. The thermodynamic advantages of fuel elements with variable properties along the length of the rod were determined. Equations and graphs for determining efficient heat transport along the fuel element are included. (R.V.J.)

1887 BURN-UP OF REACTOR FUEL AND FUEL ADMINISTRATION. Micheelsen, B. (Danish Atomic Energy Research Establishment, Risoe). Ing.-Forskn., 76: 44-7(Feb. 1967). (In Danish).

The physical background and the equations to be solved are briefly described for burnup calculations for reactor fuel. The behavior of the reactor core during various fuel shuffling schemes is sketched, and results from a two dimensional calculation of burnup and shuffling are given. (tr-auth)

1888 TOOL FOR MEASURING BOW AND ELONGATION IN FUEL-ELEMENT BUNDLES. Cashwell, R. J.; Walsh, R. C. (Univ. of Wisconsin, Madison). Nucl. Appl., 3: 699-700(Nov. 1967).

A device for measuring bow and elongation of fuel elements while still assembled in four-element bundles is described. Operation is outlined. (auth)

1889 DIGITAL REACTOR PHYSICS CALCULATIONS. [PART I.] Bustraan, M. Atoomenergie Haar Toepass., 9: 169-76(July-Aug. 1967). (In Dutch).

The method for the calculation of the Boltzmann equation and of group constants within the framework of the Dutch computer program was outlined. (tr-auth)

1890 TRANSIENT TEMPERATURE DISTRIBUTION IN THE CLAD OF A CYLINDRICAL FUEL ELEMENT. Ciechanowicz, W. (Inst. of Nuclear Research, Swierk, Poland). Nucl. Eng. Design, 6: 181-4(1967).

A solution of the partial differential equation describing transient thermal processes in the clad of a cylindrical fuel element is presented. This equation is solved by Laplace transform on the assumptions that the coolant temperature is not a function of time and the conduction in the longitudinal direction is neglected. As a result the distribution of the clad temperature with respect to time and radius coordinate is obtained. (auth)

1891 PEEP HOLES PACKED WITH LABYRINTHINE METALLIC JOINTS: PROBLEM CONNECTED WITH THE CONSTRUCTION OF NUCLEAR REACTORS. Bula, K.; Jenni, H. P. Rev. Tec. Sulzer, 21: 57-9(1966). (In Spanish).

The pressure containers of shielded operational units must be provided with peep holes. The pressure and temperature conditions have permitted a simple seal by means of plug rings with circular cross section. The test made shows that a good air tightness is necessary, particularly when using He_2 as a pressure medium. The required air tightness can not be obtained in this manner for He_2. With a labyrinthine metallic junction of Anticorrodal A, the requirements can be met. The principles of the construction and the results obtained are reported. (tr-auth)

1892 NUCLEAR FUEL ELEMENT. Demaison-Mermet, Paul; Hodasava, Pierre; Martinet, Pierre (to Commissariat a l'Energie Atomique). British Patent 1,088,786. Oct. 25, 1967. Priority date July 9, 1965, France.

A nuclear fuel element fabrication method is described which comprises encasing a fuel rod in a can, fitting end-caps on the can, employing temporary units for plugging recesses in the end-caps, welding the end-caps to the can, and pressing the can in tight contact with the fuel material. The temporary units serve the purpose of plugging recesses intended to accommodate components for centering the fuel element with respect to adjacent fuel elements and protect the end-caps from deformation during the welding and canning processes. (H.D.R.)

1893 FUEL HANDLING APPARATUS FOR NUCLEAR REACTORS. Frame, Alexander Gilchrist; Parker, Horace Frank; Stacey, John; Riley, Peter Liptrot (to United Kingdom Atomic Energy Authority). British Patent 1,087,865. Oct. 18, 1967. Filed June 25, 1963.

The design for a reactor loading and unloading machine is presented. The machine consists of a radial arm which sweeps through an arc below the core and a tiller operating opposite the radial arm above the core. As the radial arm withdraws a fuel element, the tiller above the arm inserts a key in the vacant fuel lattice opening. (D.C.C.)

1894 IMPROVEMENTS IN AND RELATING TO NUCLEAR REACTORS. (to Sulzer Brothers Ltd.). British Patent 1,088,740. Oct. 25, 1967. Priority date Sept. 10, 1964, Switzerland.

A method of controlling the power of a reactor by control rods moving lengthwise into and out of the reactor core is presented. The design requires that at any given time during operation some of the control rods are in one end position while some of the other rods are in the other end position and at least one rod is in an intermediate position between the two end positions. (D.C.C.)

1895 NUCLEAR FUEL ASSEMBLIES. Webb, John; Ward, Bernard (to United Kingdom Atomic Energy Authority). British Patent 1,088,022. Oct. 18, 1967. Filed Feb. 13, 1964.

The design of spacer grids for reactor fuel element assembly having elongated fuel elements arranged with parallel longitudinal axes is presented. The spacer grids are designed to divert streams of coolant into swirls around the fuel elements as they pass from the top of the assembly to the bottom. (D.C.C.)

1896 IMPROVEMENTS IN OR RELATING TO NUCLEAR REACTORS. (to Babcock and Wilcox Ltd.). British Patent 1,088,606. Oct. 25, 1967. Priority date Aug. 4, 1964, Germany.

In one type of reactor design the pressure vessel contains the core with the heat exchange assemblies located between the core and the pressure vessel wall. The pressure vessel is filled with coolant until the core and heat exchange assemblies are submerged. During operation the coolant circulates upwardly through the core and downwardly over the heat exchange tubes. The invention described allows one or more assemblies such as heat exchange assemblies to be supported in the pressure vessel from a plenum chamber by a convergent surface casing. By forming a convergent casing on the plenum chamber to receive the convergent casing of the supported assembly, a fluid flow passage for the coolant is provided. (D.C.C.)

1897 NUCLEAR REACTOR CONTROL MECHANISMS. Challender, Ronald Scott (to United Kingdom Atomic Energy Authority). British Patent 1,087,493. Oct. 18, 1967. Filed Mar. 17, 1965.

A control rod drive mechanism which utilizes both normal operational control movement and emergency shutdown movement for the same control rod is described. (D.C.C.)

1898 NUCLEAR FUEL ELEMENTS. Alfille, L.; Briola, J.; Chambaud, B.; Dufresne, J. (to Communaute Europeenne de l'Energie Atomique). Canadian Patent 758,197. May 2, 1967. Priority date Mar. 7, 1962, Belgium.

Finned fuel rods are assembled in clusters using prismatic blocks of graphite or Be with a half round housing on two sides to receive the fuel element. The blocks are placed side by side according to planes parallel to the axis of the fuel elements. The prismatic blocks and fuel elements are of equal length and matrix is bound with Al rings to form a fuel bundle. The arrangement allows slight deformation to occur during operating stresses so that fracture is avoided. (F.S.A.)

1899 COMBUSTIBLE ELEMENT FOR NUCLEAR REACTORS WITH PRESSURE TUBES. Alfille, L.; Briola, J.; Dufresne, J.; Ohlmer, E. (to Communaute Europeenne de l'Energie Atomique). Canadian Patent 758,198. May 2, 1967. Priority date Apr. 17, 1962, Italy.

Fuel bundles consisting of parallel fissile rods intended for placement end to end in a reactor fuel channel are described. The pressure tubes containing the bundles have a thick insulated wall so the exterior wall transfers little fission heat to the heavy water moderator. The individual bundles are joined to each other by mechanical means so that the alignment facilitates the coolant flow over the fuel elements. (F.S.A.)

1900 IMPROVEMENTS IN FUEL ELEMENTS. (to Reactor Centrum Nederland (Stitchting)). British Patent 1,087,433. Oct. 18, 1967. Priority date Feb. 21, 1964, Netherlands.

The description of a poison plate for use in a reactor fuel rod is presented. The poison material composed of dysprosium, europium, or a compound of the metals with a particle size of 150 to 200 microns is embedded in a carrier substance such as graphite, stainless steel, or Zr. Carrier substances may also be made of Al_2O_3 or SiO_2. (D.C.C.)

1901 GRABS FOR HANDLING NUCLEAR FUEL ELEMENTS. Backs, Helmut; Godin, Daniel; Maulard, Jean; Rivet, Claude (to Commissariat a l'Energie Atomique). British Patent 1,088,969. Oct. 25, 1967. Priority date Aug. 13, 1965, France.

The design for a grab for handling reactor fuel elements is presented. The grab is comprised of a cylindrical body with an electrical motor and screw-nut system for translational movement. The grab mechanism is located on a stationary grid above the reactor core. (D.C.C.)

1902 END CLOSURE FOR NUCLEAR REACTOR CHANNEL. Cepkauskas, M. D.; Rohlin, J. F. (to U. S. Atomic Energy Commission). U. S. Patent 3,353,566. Nov. 21, 1967.

An end closure for a fuel or process channel of a nuclear reactor which may be removed from and inserted into the channel by application of solely linear movement is described. A body portion of the end closure has three coaxial housings and a latch member operated by linear movement of the housings, and a seal member portion has a radially expandable sealing lip which is actuated by its linear movement against an end of one of the housings. A suitable manipulating tool detents into one of the housings and has relatively longitudinally movable coaxial shafts. (AEC)

1903 A SHOCK ABSORBER MORE PARTICULARLY FOR NUCLEAR REACTOR FUEL ELEMENTS. Mougey, Louis (to Electricite De France). British Patent 1,087,217. Oct. 18, 1967. Priority date June 15, 1965, France.

The design of a small volume shock absorber to be fitted beneath fuel element channels is presented. The shock absorber forms an extension for the fuel element channel with a basket or cup-shaped member passing through the bottom. An energy absorbing material of known tensile strength resistance receives the force of the basket or cup-shaped member as it slides through the bottom of the fuel channel. The action of the fuel element force causes elongation and even breakage of the energy absorbing element. The basket slides through the bottom of the fuel channel on a flange bearing. One or more energy absorbing materials may be used to provide successive shock-absorption. (D.C.C.)

1904 DEVICE FOR CHANGING THE CORE POSITION OF NUCLEAR REACTOR FUEL RODS. Kumpf, H.; Weber, R.; Schubert, F. (to Siemens-Schuckertwerke Aktiengesellschaft). Canadian Patent 758,199. May 2, 1967. Priority date July 29, 1961, Germany.

A column of fuel elements having operationally detachable couplings may have their individual core positions changed so that each element is uniformly irradiated. A magazine containing two chambers is mounted in the fuel channel, one being empty when the transposing operation takes place. An aligning tool and associated mechanism shifts the fuel elements in the channel housing which is filled with reactor coolant. Displacement or rotation of the magazine enables the fuel element column to be broken into its individual parts and re-assembled in a new sequence. It is evidently designed for reactors with vertical fuel channels. (F.S.A.)

1905 NUCLEAR REACTOR CORE ELEMENTS POSITION ADJUSTING DEVICE. Jouin, J. (to Commissariat a l'Energie Atomique). Canadian Patent 754,686. Mar. 14, 1967. Priority date Apr. 13, 1962, France.

In a swimming pool reactor the device is used to place in position a series of fuel elements according to the nodes of a lattice having a variable pitch whether square, rectangular or triangular. It consists of a square frame with cross members from which individual fuel elements are suspended in the tank. A geared driving mechanism and trolleys allow independent movement of each cross member and the suspended fuel element, so that any desired two-dimensional arrangement may be achieved. (F.S.A.)

1906 REACTOR COOLING. Bell, A. (to Foster Wheeler Corp.). Canadian Patent 759,343. May 23, 1967.

A description is given of a mechanical joint by which a driving mechanism may be connected to a control rod in a nuclear reactor pressure vessel. Outside the vessel the tube containing the rod has an annular enlargement machined to bear accurately on the outer surface of the vessel encompassing the hole through which the tube passes. The inner end of the tube is threaded to receive a nut so as to engage an accurately machined facing on the inner surface of the vessel. A leak-proof joint is attained by seal welding between the nut and the inner machined face and between the nut and the tube. (F.S.A.)

1907 ENERGY ABSORBING DEVICES. Cairns, Walter John; Greenhalgh, Frank Geoffrey (to United Kingdom Atomic Energy Authority). British Patent 1,082,052. Sept. 6, 1967. Filed May 7, 1964.

A nuclear reactor is described which includes an energy absorbing device to prevent the accidental free fall of a fuel element or part thereof into the core during charging or discharging the fuel element channel. The device has, in combination with the fuel body member and the pressure tube, a sleeve having a continuous zig zag guide groove and a guide pin or pins sliding in the groove to impart an oscillatory motion to the fuel member about its longitudinal axis. The sleeve, of deformable material and construction, is designed to crumple when the kinetic energy of the fuel body exceeds a predetermined value and jam the body within the tube, thus preventing further movement. (P.G.C.)

1908 IMPROVEMENTS IN AND RELATING TO STEAM GENERATORS. Heathcote, John (to Foster Wheeler Ltd.). British Patent 1,078,643. Aug. 9, 1967. Filed May 7, 1963.

A steam generator for a gas-cooled reactor comprises a shell-and-tube heat exchanger in which the heating surface is provided by a bank of bayonet-tube pairs composed of inner and outer tubes and an intermediate coaxial tube which traps the heating fluid thereby serving as an insulator to limit reduction of temperature of the heating fluid from the time it enters the steam generator to the time it begins to transfer heat to the water to be evaporated. (P.G.C.)

1909 APPLICATION OF FLUIDICS TO THE DETECTION OF BURST FUEL ELEMENTS IN NUCLEAR REACTORS. Fisher, M. J.; Thomson, A. (British Hydromechanics Research Association, Bedford, Eng.). Paper K5 of Second Cranfield Fluidics Conference, 3rd–5th January, 1967, Cambridge.

The development of wall attachment amplifiers as fluid switches for use in a fluid sampling system for locating burst fuel elements is described. The primary concern in this application is that a fluid sample is not contaminated or diluted by fluid from another source. The output characteristics of various amplifiers were examined with this in mind. Changes due to entrained gas and input flow variations were also studied. Some of the problems encountered in connecting these amplifiers in a ring counter circuit are described. (auth)

1910 ELECTRIC PROTECTION SYSTEM FOR NUCLEAR REACTORS. Troeger, H. (to Siemens-Schuckertwerke Aktiengesellschaft). Canadian Patent 760,043. May 30, 1967. Priority date June 1, 1962, Germany.

A safety circuit for reactor shutdown is described using three sensors for each potentially dangerous condition. Each probe has three contacts with each shut-off line divided into two parallel branches and having a relay coil in series with each branch. The circuit is such that the reactor is shut down if two out of three of the relay coils are unenergized. (F.S.A.)

1911 HEAT EXCHANGE APPARATUS AND NUCLEAR REACTOR DESIGNED FOR THE USE OF SAID APPARATUS. Costes, D. (to CEA). Canadian Patent 763,041. July 11, 1967. Priority date Apr. 13, 1962, France.

A heat exchange apparatus using two fluids for operation within a reactor is described. One fluid circulates in a casing of 4 in. diameter broken into short units which can be assembled with fluid tight joints. The casing walls are designed to withstand considerable pressure. Each short unit contains about 100 fine tubes in which another fluid circulates. A system of header chambers collects and maintains the flow in the fine tubes from unit to unit. Baffles are used to facilitate good heat transfer. Necessary pumps and flow control devices are included. (F.S.A.)

GENERAL

1912 (BDX-613-98) REPORT ON DEVELOPMENT OF INDUCTANCE STANDARDS. Simpson, H. E. (Bendix Corp., Kansas City, Mo.). July 1967. Contract AT(29-1)-613. 15p. Dep. CFSTI.

A set of standards was developed to meet the demands for precision inductors in the range from 0.05 μH to 100 μH. The standard inductors are repeatable, well defined and usuable over a frequency range from 1 kHz to 2.5 MHz, and provide suitable devices for the comparison of unknown inductors. Precision connector type inductance standards were developed. The inductors employ binding post connections on $\frac{3}{4}$-in. centers with separate shorting terminals which provide a definite standardizing condition. (F.S.)

1913 (BNL-11690) DISPOSITION OF MICROTUBULES IN PLANT CELLS DURING INTERPHASE AND MITOSIS. Ledbetter, Myron C. (Brookhaven National Lab., Upton, N. Y.). [1967]. 25p. (CONF-660953-1). Dep. CFSTI.

From Symposium on the Formation and Fate of Cell Organelles, Cambridge, England.

A description of the microtubules in association with certain cytoplasmic events as exhibited in cells of higher plants at interphase and during the events of mitosis is presented. The fine structure of microtubules is discussed. Features of the events are illustrated by three-dimensional reconstructions based on the study of electron micrographs and published literature. (32 references). (B.H.S.)

1914 (BNWL-525) PLUTONIUM ABSTRACTS. Volume 7, Number 7. Russell, Barbara G. (ed.) (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). July 31, 1967. Contract AT(45-1)-1830. 64p. Dep. CFSTI.

One hundred and twenty references, with abstracts, are presented on plutonium studies in the following subject fields: biology and medicine, chemistry, health and safety, metals and ceramics, miscellaneous, physics, and reactor technology. (M.C.G.)

1915 (BNWL-550) PLUTONIUM ABSTRACTS, VOLUME 7, NUMBER 8. Russell, Barbara G. (ed.) (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Aug. 31, 1967. Contract AT(45-1)-1830. 52p. Dep. CFSTI.

Ninety-nine references, with abstracts, on plutonium technology are presented, covering the following subject fields: biology and medicine, chemistry, health and safety, metallurgy and ceramics, miscellaneous, physics, and reactor technology. (M.C.G.)

1916 (COO-958-12) TECHNICAL PROGRESS REPORT [ON PHYSICAL CHEMISTRY], SEPTEMBER 13, 1966-SEPTEMBER 15, 1967. Dye, James L. (Michigan State Univ., East Lansing). Sept. 15, 1967. Contract AT(11-1)-958. 8p. Dep. CFSTI.

Research progress is reported on EPR spectra of alkali metals in pure and mixed solvents. The effects of solvent purity are being determined. Investigations of the kinetics of fast reactions using stopped-flow techniques were continued in two general areas: reactions between alkali metal solutions and solutes in ethylenediamine and reactions of Aromatic anions in ethylenediamine and other solvents. Some ab initio molecular orbital calculations on model systems were initiated. (M.C.G.)

1917 (COO-1265-42) PROGRAMMING MANUAL, VERSION 1. Goodwin, Robert W.; Hobbie, Russell K. (Minnesota Univ., Minneapolis. John H. Williams Lab. of Nuclear Physics). Jan. 15, 1967. Contract AT(11-1)-1265. 58p. Dep. CFSTI.

A computer programming manual is presented. (W.H.K.)

1918 (COO-1329-6) POPULATION DYNAMICS, MOVEMENT, AND HOME RANGE OF BLACK-TAILED JACKRABBITS (LEPUS CALIFORNICUS) IN CURLEW VALLEY, NORTHERN UTAH. Technical Progress Report, July 15, 1966-July 14, 1967. Wagner, Frederic H. (Utah State Univ., Logan. Dept. of Wildlife Resources). July 15, 1967. Contract AT(11-1)-1329. 12p. Dep. CFSTI.

Methods of determining indices of population change are described and results of the Curlew Valley population transects are presented in the form of a table. Studies on reproductive rate included determination of the mean number of fetuses per pregnant female per month, determination of monthly pregnancy rate, and determination of product of monthly litter sizes and monthly pregnancy rates. Mortality rates were obtained by comparing the March census with the number of adults per mile of subsequent October census, their value resulting from the product of total animals counted per mile in October and the percentage of adults in the October collection. Between October, 1965, and March, 1967, the population continued the gradual decline begun in the fall of 1963. This was caused by heavy mortality that offset the high reproductive rate of the population. (H.L.W.)

1919 (COO-1422-15) RELIABILITY OF MEASURING CHANGES IN BONE MINERAL CONTENT AS A FUNCTION OF THE PRECISION OF THE MEASUREMENT. Sorenson, James A.; Cameron, John R. (Wisconsin Univ., Madison. Dept. of Radiology). Aug. 1, 1967. Contract AT(11-1)-1422. 6p. Dep. CFSTI.

The precision of the direct photon absorption technique for determining bone mineral content is discussed. Modifications of the mathematical model used with this technique that will account for random sources of uncertainty in the measurements are presented. It was assumed that measurements made by this technique have a Gaussian distribution. An exact solution to the proposed equation was not found; however, an approximate solution was deemed possible through the use of tables of Gaussian functions and integrals and numerical integration. (B.H.S.)

1920 (COO-1422-16) DATA RECORDING SYSTEM FOR BONE MINERAL MEASUREMENTS. Sorenson, James A.; Cameron, John R. (Wisconsin Univ., Madison. Dept. of Radiology). Aug. 1, 1967. Contract AT(11-1)-1422. 6p. Dep. CFSTI.

A data recording system for bone mineral measurements is described. A listing of the information stored and the format and coding system are presented. (B.H.S.)

1921 (COO-1422-19) MODIFICATIONS TO COMPUTER PROGRAM TO DETERMINE BONE MINERAL CONTENT. Witt, Robert; Sadrzadeh-Raffii, Ali; Cameron, John R.; Sorenson, James A. (Wisconsin Univ., Madison. Dept. of Radiology). Aug. 1, 1967. Contract AT(11-1)-1422. 22p. Dep. CFSTI.

The following changes were made in a computer program used in the determination of bone mineral content: the program was changed from machine language to FORTRAN 63; the input mode was modified so that data could be read from either magnetic tape or IBM cards; and additional check was added in the I_t^t determination (I_t^t = photon transmission rate through soft tissue); and the manner in which the individual scans were evaluated was changed so that each of the scans for a given subject was evaluated completely separately. The reasons why the changes were made and the procedures used in making the changes are outlined and discussed. (B.H.S.)

1922 (EUR-3622e) SAHYB-2: A PROGRAMME FOR THE SOLUTION OF DIFFERENTIAL EQUATIONS USING AN ANALOGUE-ORIENTED LANGUAGE. d'Hoop, H.; Monterosso, R. (European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center. European Atomic Energy Community, Ispra (Italy). European Scientific Data Processing Center). July 7, 1967. 94p. Dep.

The computer program SAHYB-2 for the solution of differential equations is presented. SAHYB-2 uses as language a subset of FORTRAN-360 statements. This program is developed for the IBM 7090 and the IBM 360/65 computers. (W.H.K.)

1923 (K-L-6070-2) BAND RECOVERY APPARATUS OPERATING AND MAINTENANCE MANUAL. Jamieson, G. R. (comp.) (Oak Ridge Gaseous Diffusion Plant, Tenn.). Sept. 28, 1967. Contract W-7405-eng-26. 9p. Dep. CFSTI.

An operating and maintenance manual is presented for a band recovery apparatus, which is a motor-driven, syringe-type liquid withdrawal unit for slowly removing thin layers of isopycnically banded materials from density gradients in ultracentrifuge tubes. (B.G.D.)

1924 (LA-3733) AN IMPROVED MOLTEN SALT EMF CELL. STUDIES USING $SnCl_2$ AND TIN ALLOYED WITH Cu, Ag, OR Au TO TEST FOR RAOULT'S LAW BEHAVIOR. Elliott, G. R. B.; Lemons, J. F. (Los Alamos Scientific Lab., N. Mex.). Mar. 1, 1967. Contract W-7405-eng-36. 8p. Dep. CFSTI.

An H-cell was designed to provide for stirring and solute addition in a sealed, isolated, and heated system. Measurements at 535°K were made using dilute solute, X, and cells of the type: $W-Sn_{(l)}/SnCl_{2(l)}/Sn, X_{(Soln)}-W$. The cell voltages were constant at any time to a few tenths of a microvolt with day-to-day variations generally less than 1 μv. Unlike many precise vapor pressure measurements that failed to indicate approach to the slope of Raoult's law in similar composition regions, these measurements for copper, silver, and gold solutions lie very close to Raoult's law at their dilute limit. For tin with silver, the data deviate from Raoult's law by following a term in the square of the solute mole fraction; with gold, the deviations are more

complex and are interpreted in terms of solution structure. Possible inaccuracies in thermodynamic prediction are discussed. (auth)

1925 (LA-3764) THE TIME-DEPENDENT REACTION ZONES OF IDEAL GASES, NITROMETHANE, AND LIQUID TNT. Mader, Charles L. (Los Alamos Scientific Lab., N. Mex.). Aug. 1967. Contract W-7405-eng-36. 28p. Dep. CFSTI.

The time-dependent reaction zones of ideal gases, nitromethane, and liquid TNT were investigated using two-dimensional Lagrangian and Eulerian numerical hydrodynamics with Arrhenius chemical reaction and accurate equations of state. The unperturbed two-dimensional Lagrangian and Eulerian calculations yielded the same results regarding the stability of the steady-state solutions of the reaction zone as did previously reported calculations using one-dimensional Lagrangian and characteristic methods. The perturbed two-dimensional Lagrangian and Eulerian calculations reproduced the analytical predictions of Erpenbeck regarding the stability of the ideal gas reaction zone in two dimensions and indicated that the stabilities of the reaction zones of nitromethane and liquid TNT are identical in one and two dimensions. (auth)

1926 (NYO-3588-6) NUCLEIC ACIDS AND PROTEIN SYNTHESIZING MECHANISMS OF MITOCHONDRIA. Annual Progress Report. Suyama, Yoshitaka (Pennsylvania Univ., Philadelphia. Dept. of Biology). June 28, 1967. Contract AT(30-1)-3588. 24p. Dep. CFSTI.

Ribonucleic acids present in mitochondria of Tetrahymena were isolated and characterized; the origins of these RNA's were examined by DNA-RNA hybridization studies. Progress is also reported on studies concerned with the synthesis of marcomolecules, RNA, DNA, and protein in isolated mitochondria of Tetrahymena. (37 references). (B.H.S.)

1927 (NYO-3729-1) [PLANT MITOCHONDRIAL RESPIRATION]. Progress Report. Bonner, Walter D. (Pennsylvania Univ., Philadelphia. Johnson Research Foundation). Sept. 19, 1967. Contract AT(30-1)-3729. 8p. Dep. CFSTI.

Progress is reported on studies on respiration in plant mitochondria. Emphasis was placed on studies of the organization of mitochondrial respiratory chain. (C.H.)

1928 (NYO-3748-7) PRE-PROCESSING OF BIOLOGICAL IMAGES FOR COMPUTER ANALYSIS. Vetter, Henri G.; Neurath, Peter W. (New England Medical Center Hospitals, Boston, Mass.). July 31, 1967. Contract AT(30-1)-3748. 2p. (CONF-671106-1). Dep. CFSTI.

From 20th Annual Conference on Engineering in Medicine and Biology, Boston, Mass.

An automated method for preprocessing biological images for computer analysis by following an isodensity contour is described. (B.G.D.)

1929 (NYO-3794-1) DETERMINATIONS OF ELEMENTARY REACTION RATE CONSTANTS FOR THE REACTIONS OF HYDROGEN ATOMS WITH VARIOUS SUBSTRATE MOLECULES IN THE GAS PHASE. Annual Progress Report, 1966-67. (Carnegie-Mellon Univ., Pittsburgh, Pa. Dept. of Chemistry). Oct. 1, 1967. Contract AT(30-1)-3794. 30p. Dep. CFSTI.

Experimental measurements of quantities needed to determine the oscillator strength of the $^2P_{\frac{1}{2},\frac{3}{2}} - {}^2S_{\frac{1}{2}}$ transition in the hydrogen atom are described. The data were obtained for a lamp with an emitting thickness of 1.5 cm. The technique of Lyman α photometry was demonstrated to be one of the most sensitive methods available for detection of ground-state hydrogen atoms. (M.C.G.)

1930 (RISO-M-590) PDP8 FREQUENCY-RESPONSE CALCULATOR. Poulsen, N. J. (Danish Atomic Energy Commission, Risoe. Research Establishment). Aug. 1967. 54p. (R-13-67). Dep.

The program is used for calculating the frequency-response of a transfer-function consisting of any mixture of following three functions: EXP (-T(s)/N(s)), (1 - EXP (-T(s)/N(s)))/s, and k · T(s)/N(s) where T(s) and N(s) in the three mentioned cases do not need to be the same functions. The output appears in the following format: Frequency (rad/sec), amplitude (dB), angle (degrees). (auth)

1931 (SC-DC-67-1948) GB-LIDAR SYSTEM. Landry, Murphy J.; Lochner, Jerrel R. (Sandia Corp., Albuquerque, N. Mex.). Sept. 1967. Contract AT(29-1)-789. 21p. (CONF-671015-1). Dep. CFSTI.

From Seminar in Depth on Laser Range Instrumentation, El Paso, Tex.

The design of a mobile laser (lidar) system for detecting artificial clouds composed of ablative materials from re-entry vehicles is presented. Data from evaluation studies in which the laser energy was reflected from stationary, slow-velocity, and low- and high-energy targets are presented. (W.H.K.)

1932 (SC-RR-67-688) PRINCIPLES OF OPERATION OF THE VACUUM PROBE MICROBIOLOGICAL SAMPLER. Dugan, V. L. (Sandia Corp., Albuquerque, N. Mex.). Aug. 1967. Contracts AT(29-1)-789; R-09-019-040. 28p. Dep. CFSTI.

The physical design of the vacuum probe for microbiological sampling, which has been designated the "hand probe" or the "filter probe," and a suggested protocol for the repeated use of this instrument are presented. Also included are a discussion of how the probe's critical orifice varies with atmospheric pressure and vacuum pressure and how small particles may be influenced by the sonic noise which is produced by the operation of the orifice. (auth)

1933 (SCL-DR-67-88) ANALYSIS OF SHOCK-FRONT IRREGULARITIES IN THE COLD-GAS SHOCK TUBE WITH SULFUR HEXAFLUORIDE AS THE DRIVEN GAS. Posehn, M. R. (Sandia Corp., Livermore, Calif.). Oct. 1967. Contract AT(29-1)-789. 52p. Dep. CFSTI.

Results of a series of tests in a cold-gas shock tube using sulfur hexafluoride as the driven gas are described. These tests showed that air contamination levels up to five percent by volume and decomposition of the gas at temperatures below 1200°F have little influence on the formation of the shock front. Irregular shock fronts formed, when the initial pressure of the sulfur hexafluoride was greater than one psia. The irregularities were attributed to transverse waves and perturbations caused by the bursting of the diaphragm. An analysis carried out by A. Emery and W. Ashurst concurrently with the tests showed that transverse waves and perturbations are attenuated more rapidly when the initial pressure of the sulfur hexafluoride is low. Another analysis indicates a similar effect when the acoustic impedance ratio across the contract surface is less than unity. (auth)

1934 (TID-24087) DESIGN OF A GRAPHIC DISPLAY SYSTEM. Report No. 67-36. Coggan, B. B. (California Univ., Los Angeles. Dept. of Engineering). Aug. 1967. Contract AT-11-1-GEN-10. 192p. Dep. CFSTI.

The basic specifications are described for a Graphic Display System that is designed to handle two areas of application: use as a special-purpose device for the control of an instrumentation system, and observation; and use as a general purpose display device that is capable of defining reasonably complex structures which will be useful to a broad field of application programs. Existing systems are first surveyed, the basic concepts of engineering graphics are studied, and specific instrumentation display requirements are discussed. Finally, this information is used to derive the basic specification for a visual information processor (VIP) that will satisfy the given constraints. (auth)

1935 (UCRL-17743) ELECTRON SPIN RESONANCE STUDIES OF RADICALS PRODUCED BY ELECTROLYSIS. Talcott, Carolyn L. (California Univ., Berkeley. Lawrence Radiation Lab.). Sept. 1967. Contract W-7405-eng-48. 124p. Dep. CFSTI.

Thesis.

The ESR spectra of the radical anions of pyridine, pyrimidine, and pyrazine in liquid ammonia were measured. The coupling constants obtained from these spectra allowed values of the quantities Q^N_N, $Q^N_{C_N}$, and $Q^H_{C_H}$ to be determined without relying on calculated spin densities. The values found are: $Q^N_N = +27.3$ gauss, $Q^N_{C_N} = -1.7$ gauss, and $Q^H_{C_H} = -24.5$ gauss. Theoretical values for the parameters Q^N_N (pyridine, pyridine N-oxide, nitrosobenzene, and nitrobenzene), $Q^C_{C_N}$, and $Q^C_{C_N}$ were calculated using configuration interaction in a MO framework. The ESR spectra of several substituted pyridine radical anions in liquid ammonia are reported including: 4-picoline, 3,5-lutidine, pyridine N-oxide, 4-picoline N-oxide, and 2,6-lutidine N-oxide. A series of McLachlan type spin density calculations were carried out in order to determine values of the variable parameters appropriate for the various N-heterocyclic radical anions. Excellent agreement between experimental and calculated spin densities was obtained for the simple heterocyclics and for the methyl-substituted pyridines. The parameters for N-oxides were not as well determined. USCF calculations including an approximate doublet state projection operator were carried out for the unsubstituted N-heterocyclics and for pyridine N-oxide with the resulting spin densities slightly better than those calculated using the McLachlan approximation. The ESR spectra of the radical anions of nitrosobenzene in DMSO and THF and of ortho- and para-nitrosotoluene and 2-nitroso-m-xylene in liquid ammonia were measured. The values of the coupling constants determined for the methylnitrosobenzenes corresponded to an assignment of the larger ortho-proton coupling constant observed in the nitrosobenzene radical anion to the proton nearest the oxygen atom. This is consistent with the assignment predicted by including non-neighbor resonance integrals in the

MO calculations of spin density distribution. An additional mechanism whereby the ls_N electrons are polarized by spin density in the oxygen pi orbital was proposed and values of the parameters Q^H_{CHC} and Q^H_{CHO} were estimated using simple three center MO's. McLachlan calculations for the nitrosobenzene radical anions were carried out using several models to account for the effects of restricted rotation. In each case it was found that several sets of parameters gave equally good predictions of the ring position spin densities, with wide variation of the predicted distribution in the nitroso group. USCF calculations were carried out for the nitrosobenzene radical anion and similar ambiguity in the choice of parameters was found. In the absence of non-neighbor integrals, the USCF wave functions predict a larger spin density in the ortho-carbon atom, which is further from the oxygen atom. (auth)

1936 (UCRL-17807) THEORETICAL ANALYSIS OF THE MOVING BOUNDARY MEASUREMENT OF TRANSFERENCE NUMBERS. Milios, Paul (California Univ., Berkeley. Lawrence Radiation Lab.). Sept. 1967. Contract W-7405-eng-48. 57p. Dep. CFSTI.

Thesis.

A moving boundary system was analyzed and an equation for the transference number derived. The equation is valid for concentrated as well as dilute solutions. When the partial molal volume of the solvent is constant through the boundary, the equation reduces to the approximate equation now in common use. The cation transference number in 0.213M NH_4NO_3 was experimentally determined and found to be equal to 0.5140 ± 0.0024. (auth)

1937 (UR-49-814) COMPUTER CONTROL OF BEHAVIORAL EXPERIMENTS. Siegel, Louis (Rochester Univ., N. Y. Dept. of Radiation Biology and Biophysics). July 27, 1967. Contract W-7405-eng-49. 11p. (CONF-670918-1). Dep. CFSTI.

From American Psychological Association, Washington, D. C.

It is shown how the LINE computer goes about executing a particular schedule of reinforcement, a Fixed Ratio 7, for behavioral experiments. (B.G.D.)

1938 (Y-DM-6) INDEX OF TECHNICAL REPORTS ON MACHINING AND DIMENSIONAL MEASUREMENT. Broders, M. A. (Union Carbide Corp., Oak Ridge, Tenn. Y-12 Plant). Sept. 26, 1967. Contract W-7405-eng-26. 40p. Dep. CFSTI.

A KWIC-Permuted Title Index has been prepared for selected technical reports published by private industry and various US Government activities on the subjects of Machining and Dimensional Measurement. Technical reports published by the AEC and its contractors are not referenced in this index in view of the fact that a separate index has been prepared by the Machining and Gaging Information Center (MAGIC) to cover specifically this segment of the report literature. The index consists of three major sections: a permuted title subject index, personal author index, and a bibliographic section. The bibliographic section is arranged according to corporate author and includes a title, personal author, report designation, and report availability. (auth)

1939 (AI-Trans-257) DISSOCIATION VOLTAGE, LIMITING CURRENT DENSITY, AND CONDUCTIVITY OF ALUMINUM CHLORIDE CONTAINING MELTS. Grothe, H. Translated for Atomics International, Canoga Park, Calif., from Z. Elektrochem., 53: 362-9(1949). 18p. Dep. CFSTI. JCL $1.60 fs, $0.80 mf.

The dissociation voltage of aluminum chloride in the melt from 400 to 780°C was experimentally determined according to theoretical calculation in molten $KAlCl_4$ and in mixtures with $MgCl_2$ and LiCl. The value $E_{fug}^{3} = 2.01$ and 1.92 v respectively is in good agreement with the calculated value. The limiting current density for Al^{3+} in chloride melts with $MgCl_2$ is higher than 1 a/cm^2. The density of the $KAlCl_4$ complex in the molten mixture was in agreement with the formula $d_l = 1.33 - 0.6 \times 10^{-3} \times (t - 700)$. The specific conductance of the molten $KAlCl_4$ complex was determined at $\kappa = 1.563 \times 10^{-3} \times t - 0.076$. The specific conductivity of aluminum chloride-containing melts is additively composed of the conductance of the volume share of the components, if the amount of alkali chloride corresponding to the $AlCl_3$ content is regarded as a complex-bound component. From the path of the conductance curves in the $AlCl_3$-KCl system it was concluded that the degree of dissociation of salts in the melts is constant. For KCl the ratio of undissociated, polymeric molecules at the completely dissociated value is suspected to be equal to 4:3. (auth)

1940 (ANL-Trans-521) ELECTROSYNTHESIS OF O_3. XI. METHOD FOR CONNECTING OZONIZERS. Filippov, Yu. V.; Vendilo, V. P. Translated by Elmar K. Wilip (Argonne National Lab., Ill.), from Zh. Fiz. Khim., 40: 2337-40(1966). 6p. Dep. CFSTI. JCL $1.10 fs, $0.80 mf.

Using the theory of the effect of a transfer of reacting substances along a flow upon the reaction kinetics, it was shown that the increase of the operating efficiency of reactors at a consecutive connection depends on the occurrence of ozone transfer along the flow. The experimental data on ozone synthesis confirmed the advantage of a consecutive ozonizer connection along the flow which indicates the presence of an ozone transfer along the flow. (auth)

1941 (ANL-Trans-522) ELECTROSYNTHESIS OF O_3. I. KINETICS OF THE SYNTHESIS OF O_3 UNDER FLOW CONDITIONS. Filippov, Yu. V.; Emel'yanov, Yu. M. Translated by Elmar K. Wilip (Argonne National Lab., Ill.), from Zh. Fiz. Khim., 35: 407-15(1961). 14p. Dep. CFSTI. JCL $1.60 fs, $0.80 mf.

It has been shown that equations employed for describing the kinetics of ozone synthesis correspond to the limiting cases of development of transport of the reactants along the stream during reaction under flow conditions. A general kinetic equation was derived that is in good accord with the experimental data. A method is presented for determining the true decomposition and formation constants of ozone on reaction in flow. A principle for chemical reactions in electrical discharges was introduced according to which the kinetic constants are proportional to the volumetric discharge energy. (auth)

1942 (SC-T-67-0951) THEORY OF IONIZED MEDIA WITH DISTANT WALLS. Hoyaux, Max. Translated by Marcel I. Weinreich (Sandia Corp., Albuquerque, N. Mex.), from Rev. Gen. Elec., 62: 421-38(1953). 56p. Dep. CFSTI. JCL $5.60 fs, $1.91 mf.

The theory of ionized media with a symmetry of translation is discussed. This theory constitutes an important element of a study of mercury vapor rectifiers. After discussing various types of ionized media, the hypothesis of an ionized medium is used to describe a system in which the electrodes are relatively close together, while the walls are relatively distant. This theory, which makes it possible to carry on the study of problems relating to complex forms of a medium in which the discharge occurs, has been the object of experimental verifications, whose satisfactory definitions are given at the end of this article and which involve a vial with mercury vapor, of the hot-cathode type. There are two Appendices: the first is concerned with the solution of differential equations required in this theory, while the second contains a résumé of the theory dealing with the drop of potential in the arc of mercury vapor rectifiers. (auth)

1943 DIPLOMATS, SCIENTISTS, AND POLITICIANS. The United States and the Nuclear Test Ban Negotiations. Jacobson, Harold Karan; Stein, Eric. Ann Arbor, Mich., University of Michigan, 1966. 546p. $8.50.

An analysis of the impact of science and modern technology on negotiating processes and concepts of international organization is presented. Information and discussions at the conference are included on the discontinuance of nuclear weapons tests and the Moscow treaty. Introductory comments and concluding observations are also included. (J.R.D.)

Appendix I

SCOPE AND SECTION ARRANGEMENT OF NUCLEAR SCIENCE ABSTRACTS

Introduction

This appendix defines the subject matter of the literature covered in *Nuclear Science Abstracts (NSA)*. Broadly stated, the subject scope of *NSA* includes all of nuclear science and technology defined as follows:

> Nuclear science is the study of the production, properties, principles, and phenomena of atomic nuclei, subatomic particles, gamma rays, and x rays.
>
> Nuclear technology is the application of the principles and phenomena of nuclear science to other sciences and engineering, and, conversely, the application of other sciences and engineering to the problems of nuclear science.

In part 1, 10 major fields are identified which contain all the subject diversity of nuclear science and technology. Subcategories under each of these fields are listed which narrow the subject matter. Each subcategory is followed by statements of specific subject interest. These statements have been prepared to show the exact range and limits of subject interest and are the guide for selecting literature for abstracting and indexing in *NSA*.

The extent of interest in the chemical elements is contained in part 2.

An index to the descriptions of subject scope begins on page APPENDIX 19.

Selection of literature for inclusion in *NSA* is based on subject content; nothing is excluded solely on the basis of form, origin, or language. Some of the general practices followed in selecting literature for *NSA* are as follows:

1. Popular type articles are not included.
2. Textbooks below the graduate level are not included.
3. Theses below the doctoral level are not included.
4. Patents that have been filed in several countries are included only once.
5. Material existing only as abstracts or short summaries are not included except for papers summarized in the *Transactions of the American Nuclear Society*.
6. Translations are included both when an item is published in the original language and when an item appears in an English language translation.
7. All United States Atomic Energy Commission research and development reports in printed form and which have been made publicly available are included in *NSA*. Abstracts of some of these will be found under the General and Miscellaneous category. This practice also includes the printed reports from the national nuclear energy organizations of the United Kingdom, Canada, Sweden, Denmark, and Norway.
8. Related groups of engineering drawings and specifications are abstracted and indexed in *NSA* when they become publicly available.
9. As a general practice, material more than two years old is not included in *NSA*.

All journals scanned regularly are listed in Issue No. 1 of each new volume. New additions are listed in odd numbered issues.

Part 1

SCOPE AND ARRANGEMENT

1.0 CHEMISTRY

1.01 Analytical Chemistry

Chemical procedures involving the actinides or lanthanides, any radioactive element, other elements as specified under **Extent of Interest in the Elements** (Part 2), or any element or compound when the application is directly associated with nuclear technology

Isotopic analysis under all conditions other than applications in geological age estimations

Radiometric analysis under all conditions other than routine tracer studies

Activation analysis

1.02 Inorganic, Organic, and Physical Chemistry

Chemical properties of actinides, of actual or simulated fission products, or of any element, compound, or mixture when the application is directly associated with nuclear technology

Isotope effects on chemical properties and reactions

Physical chemistry and crystal structure of compounds and nonmetallic elements studied for use in connection with actual or simulated radiation environments. Structural studies in which radioisotopes are used as tools are excluded

1.03 Radiation and Nuclear Chemistry

Radiation effects on compounds and nonmetals

Radiation processes such as radioinduced polymerization or radiation catalysis

Radiolysis

Radioisotope production

See also **Separation Processes** and **ENGINEERING—Isotope Technology**

Recoil reaction mechanisms

1.04 Radiochemistry

Radiochemistry under any condition other than the preparation of labeled compounds

1.05 Separation Processes

Fuel processing and reprocessing, both radioisotope and reactor, under any condition

See also **Radiochemistry**

Chemical separation of isotopes other than analytical applications

See also **ENGINEERING—Isotope Technology**

Ore processing for thorium or uranium recovery

Waste processing for concentration, decontamination, or fission product recovery

2.0 EARTH SCIENCES

2.01 Geology and Hydrology

Movement of fallout and radioactivity through the earth, rivers, lakes, and streams

Hydrology of fallout and radioactive waste

Natural radioactivity

Radiometric techniques

See also **INSTRUMENTATION—Radiometric Instruments**

Investigations of properties of geologic materials pertinent to underground nuclear explosion technology. Site surveys for underground nuclear explosions, nuclear facilities, or for radioactive waste disposal or storage areas

2.02 Meteorology

Fallout transport and deposition

Radioactive aerosol and gas movement and dispersal

Radioactivity levels in the atmosphere

Surveys for nuclear facilities and nuclear explosion test sites

2.03 Mineralogy and Exploration

Identification, description, and estimated reserves of thorium and uranium minerals

2.04 Oceanography

Waste disposal in oceans and seas

Levels and movement of radioactivity in oceans and seas

2.05 Seismology

Nuclear explosion detection and identification systems

Seismological surveys for nuclear facilities

3.0 ENGINEERING

3.01 Nuclear Explosions

Use of nuclear (or simulated nuclear) explosions for the development of detection systems and techniques

Engineering developments and theoretical analyses associated with peaceful applications of nuclear explosions

3.02 Facilities and Equipment

Engineering studies (including economic) not specifically included in another category on the design, construction, and operation of irradiation facilities, laboratories, pilot plants, and other nuclear facilities and equipment

3.03 Heat Transfer and Fluid Flow

Theoretical studies and engineering applications of heat transfer and fluid flow to nuclear facilities, plants, or laboratories

For thermodynamics and magnetofluidynamics

See **Fluid Physics** under **PHYSICS (GENERAL)**

3.04 Isotope Technology

Design, development, fabrication, testing, and evaluation of radioisotopes as sources of heat, electricity, or propulsion energy

Design, development, fabrication, testing, and evaluation of radioisotopic fission products for use as radiation sources

Physical separation of isotopes (centrifugal, electromagnetic, gaseous diffusion and thermal diffusion)

See also **CHEMISTRY—Separation Processes**

3.05 Materials Testing

Equipment, methods, and techniques for destructive and nondestructive testing applied to nuclear technology

3.06 Protective Structures

Design, construction, and effectiveness of structures for protection against the effects of nuclear explosions and fallout

See also **LIFE SCIENCES—Health Physics and Safety**

3.07 Radioactive Material Handling

Design, construction, testing, and operation of equipment and facilities for handling, storing, or concentrating radioactive materials

3.08 Vacuum Engineering

Design, construction, and operation of ultrahigh vacuum systems and equipment, i.e., 10^{-9} torr or greater. Does not include vacuum systems and equipment that are more appropriately categorized according to the application (e.g., a vacuum system specifically intended for an accelerator is included under **PHYSICS (HIGH ENERGY)—Particle Accelerators)**

4.0 INSTRUMENTATION

4.01 Radiation Detection Instruments

General Detectors and Monitors

Nuclear Spectroscopic Instrumentation

High Energy Physics Instrumentation

4.02 Radiation Dosimeters

Design, testing, and theory

4.03 Radiometric Instruments

Design, testing, and theory of instruments which use radiation sources and detectors as means of measurement

4.04 Miscellaneous Instruments and Components

Design, performance, or testing for direct application in nuclear technology

4.05 Radiation Effects on Instruments and Instrument Components

5.0 LIFE SCIENCES

5.01 Biochemistry, Physiology, and Molecular Biology

Elucidation by radioisotopes of basic processes in biological materials at any level of organization if: the technique is new; the tracer has not been used previously in biological materials; new apparatus has been designed for tracer studies; or a new method for introducing the tracer into the biological material is described

See also **INSTRUMENTATION**

Metabolism, physiology, and toxicology of all actinide elements, all fission product elements, and all radioisotopes if the radioisotope enters the biological material in elemental form or if an isotope effect is reported or discussed

Effects of ionizing radiations, neutrons, accelerated particles, ultraviolet light, microwaves, and high intensity radiation from lasers on biological materials (enzymes, hormones, nucleic acids, cell nuclei, mitochondria, etc.) if a molecule or subcellular organelle is the level of interaction

Reactions or responses of nonirradiated hosts to challenge by irradiated materials and reactions of irradiated hosts to challenge by nonirradiated materials (host includes organizational levels from the molecule to the entire organism)

For studies at the cellular level of organization *see* **Genetics and Cytogenetics; Radiation Effects on Animals; Radiation Effects on Plants;** and **Radiation Effects on Microorganisms**

5.02 Ecology

Movement of radioisotopes, actinide elements, or fission products in animal and plant communities or ecosystems

Effects of ionizing radiations, neutrons, and accelerated particles on plant and animal communities and on ecosystems

5.03 Genetics and Cytogenetics

Radiation effects on hereditary characteristics and processes at all levels of organization (biochemical through organism) including radioinduced mutations and chromosome aberrations and characteristics of radioinduced mutants

5.04 Health Physics and Safety

Radioactive contamination and decontamination of materials (internal and external)

Measurement, calculation, or estimation of dose from radiation sources (internal and external) to which biological materials are exposed or may be exposed

Application and effectiveness of radiation protection by physical agents such as clothing, ointments, etc.

All aspects of civil defense planning related to human engineering, including studies of survival in real or simulated post-attack environment

All phases of legislative action or activities of agencies and committees (at any level) in protection of persons or groups of persons against real or anticipated radiation hazards

5.05 Medicine

Evaluation of substances for protection against, enhancement of, or amelioration of radiation effects (includes animal research)

Treatment of radiation sickness and injuries in irradiated animals and man

Use of new preparations or techniques for radiodiagnosis

Blast, thermal, and other effects of real or simulated nuclear explosions (includes studies of atomic bomb survivors)

5.06 Radiation Effects on Animals

Somatic effects of ionizing radiations, neutrons, accelerated particles, microwaves, ultraviolet light, and high intensity radiation from lasers on invertebrates

Somatic effects of ionizing radiations, neutrons, accelerated particles, microwaves, ultraviolet light, or high intensity radiation from lasers on vertebrates

Somatic effects of ionizing radiations, neutrons, accelerated particles, microwaves, ultraviolet light, and high intensity radiation from lasers on man

For effects of radiation on immune reactions and genetics, *see* **Biochemistry, Physiology,** and **Molecular Biology** and also **Genetics and Cytogenetics**

5.07 Radiation Effects on Plants

Somatic effects of ionizing radiations, neutrons, accelerated particles, ultraviolet light, microwaves, or high intensity radiation from lasers on plants

For effects of radiation at the molecular and subcellular levels, *see* **Biochemistry, Physiology,** and **Molecular Biology**

For effects of radiation on genetics, *see* **Genetics and Cytogenetics**

5.08 Radiation Effects on Microorganisms

Effects of ionizing radiations, neutrons, accelerated particles, ultraviolet light, microwaves, or high intensity radiation from lasers on bacteria, bacteriophages, rickettsia, and viruses

For effects of radiation on genetics of microorganisms, *see* **Genetics and Cytogenetics**

5.09 Radiosterilization and Radiopreservation

Food

Pests

Materials

For irradiation facilities *see also* **ENGINEERING—Facilities and Equipment**

6.0 METALS, CERAMICS, AND OTHER MATERIALS

For interest in specific elements see Part 2: **Extent of Interest in the Elements**

6.01 Metals and Alloys

Corrosion and Erosion

Involving any metal or alloy under actual or simulated reactor, separation process, or waste disposal conditions

Preparation and Fabrication

Involving application in nuclear technology

Properties Evaluations

Involving application in accelerator, reactor, or other nuclear technology

Structure and Phase Studies

Metallurgical evaluations associated with nuclear-technology applications

Radiation Effects

6.02 Ceramics and Cermets

Corrosion and Erosion

Involving any ceramic or cermet under actual or simulated reactor, separation process, or waste disposal conditions

Preparation and Fabrication

Involving application in nuclear technology

Properties Evaluations

Involving application in accelerator, reactor, or other nuclear technology

Structure and Phase Studies

Evaluations associated with nuclear-technology applications

Radiation Effects

6.03 Plastics and Other Materials

Corrosion and erosion under actual or simulated reactor, separation process, or waste disposal conditions

Preparation and fabrication for proposed or actual application in nuclear technology

Properties evaluations for applications in accelerator, reactor, or other nuclear technology

Structure and phase studies associated with evaluations for nuclear-technology applications

Radiation effects

7.0 PHYSICS (GENERAL)

7.01 Astrophysics and Cosmology

Cosmic-ray exposure ages and elemental abundance from studies of meteorites, chondrites, etc.

Stars: composition, evolution, physical conditions, and nucleogenesis

Extragalactic objects: quasi-stellar sources, blue stellar objects, radiogalaxies, and Seyfert galaxies (theory and detailed studies only, not reports on the location of the objects)

Solar phenomena: sunspots, prominences, disturbances, solar wind, solar flares, radio bursts, and magnetic field effects; origin of the solar system; and structure and spectra of the sun

Galaxies: structure, interstellar matter, x-ray sources, H II regions, etc., only as related to radiations, nuclear phenomena, and plasma physics, not celestial mechanics

Cosmology (structure and evolution of the Universe in the large)

Planetary phenomena: radiation belts (other than van Allen, for which *see* **Geophysics**), interplanetary magnetic fields, and radioemissions only

7.02 Atomic and Molecular Physics

Atomic, electron, ion, and molecular beam reactions with materials

Atomic and molecular properties of the actinides and transuranic elements

Positronium, muonium, and mesic atoms and molecules

Collision, charge-exchange, excitation, or dissociation phenomena involving electrons, ions, atoms, or molecules

Atomic theory (for general application; not when applied to or developed for a specific element)

7.03 Cosmic Radiation

All scientific and technical aspects except interactions with the earth's magnetic field, for which *see* **Geophysics**, and biological effects, for which *see* **LIFE SCIENCES**

7.04 Direct Energy Conversion

Magnetofluidmechanic, plasma, and thermionic devices and applications of thermoelectric devices to reactor or other nuclear facilities, and nuclear phenomena or techniques

7.05 Fluid Physics

Electrofluidmechanics

Magnetofluidmechanics

7.06 Geophysics

Auroral or ionospheric phenomena only when particle kinetics are discussed

Nuclear detonations and their effects at high altitude

Particle kinetics and geomagnetic trapping in van Allen radiation belts

Particle phenomena resulting from solar-wind or cosmic ray interactions with the earth's magnetic field

7.07 Low-Temperature Physics

Superconductivity

Other cryogenic studies and equipment if nuclear phenomena or techniques are involved

7.08 Plasma and Thermonuclear Physics

(Does not include antenna studies)

Confinement and Heating of Plasma

Diagnostics of Plasma

Kinetics of Plasma

Production of Plasma

Stability of Plasma

Thermonuclear Processes

7.09 Shielding

Shielding against ionizing radiation, neutrons, and accelerated particles

7.10 Solid-State Physics

Radiation effects on crystallographic or electronic properties of solids

Physical properties of actinides, lanthanides, and other elements of special metallurgical interest in nuclear technology

Moessbauer effect and nuclear magnetic resonance studies in solids (if nuclear properties are determined, *see* **PHYSICS (NUCLEAR)**)

7.11 Theoretical Physics

General quantum theory

See also **PHYSICS (HIGH-ENERGY)—Field Theories**

Other mathematical physics when directly related to nuclear science and technology

8.0 PHYSICS (HIGH ENERGY)

8.01 Particle Interactions and Properties (Experimental)

Includes all experimental studies on the electromagnetic, weak, and strong interactions and properties of particles and radiation quanta and experimental information on hyperfragments (hypernuclei) and particle or radiation quanta reactions with nuclei above the pion production threshold (~400 MeV) under the following subcategories:

Electromagnetic

Weak

Strong (Baryon-Induced)

Strong (Meson-Induced)

8.02 Particle Interactions and Properties (Theoretical)

Includes all theoretical studies on the electromagnetic, weak, and strong interactions and properties of particles and radiation quanta and theoretical information on hyperfragments (hypernuclei) and particle or radiation quanta reactions with nuclei above the pion production threshold (~400 MeV) under the following subcategories:

General

Electromagnetic

Weak

Strong (General)

Strong (Baryon No. = 0)

Strong (Baryon No. = 1)

Strong (Baryon No. $\geq$ 2)

8.03 Particle Invariance Principles and Symmetries

Includes information on the space-time symmetries and internal symmetries of particles and the applications of these symmetries to the electromagnetic, weak, and strong interactions under the following subcategories:

General

Applications to Electromagnetic and Weak Interactions

Applications to Strong Interactions

8.04 Field Theories

Includes all information on quantum field theories, quantum electrodynamics, relativistic quantum mechanics and special relativity theory, and gravitation and general relativity theory under the following subcategories:

General

Quantum Field Theory and Relativistic Mechanics

Gravitation and General Relativity Theory

8.05 Scattering Theory

Includes general scattering theory only. Information on the application of scattering theory to specific interactions of particles or types of particles is found under other subcategories according to type of interaction (i.e., electromagnetic, weak, or strong)

8.06 Particle Accelerators

Design, development, and operation, auxiliaries and components, ion sources, injection and extraction systems, ion optics and field calculations, storage rings, and experimental facilities (including radiation targets)

9.0 PHYSICS (NUCLEAR)

9.01 Neutron Interactions with Matter

Experimental and theoretical studies of neutron absorption, scattering, thermalization, transport, etc., in macroscopic systems, including solution of the neutron transport equation and theoretical neutron transport in matter in general geometric configurations

Production and calibration of neutron sources

9.02 Nuclear Properties and Reactions, $A \leq 5$, $6 \leq A \leq 19$, $20 \leq A \leq 89$, $A \geq 90$

Mass, charge distribution, binding energy, radioactive decay, energy levels and transitions, moments and spin, and nuclear reactions and scattering of specific nuclei, spontaneous and induced fission

Model calculations for specific nuclei

9.03 Nuclear Theory

Nuclear structure, nuclear matter, nuclear reactions and scattering, nuclear moments and spin, radioactive decay, spontaneous and induced fission, and nuclear models

10.0 REACTOR TECHNOLOGY

10.01 Central Power Reactors

Criticality and reactivity, control systems, shielding, cooling systems, fuels, auxiliaries, operation and performance, safety and radiation hazards, and economics

10.02 Marine and Portable Power Reactors

Criticality and reactivity, control systems, shielding, cooling systems, fuels, auxiliaries, operation and performance, safety and radiation hazards, and economics

10.03 Rocket and Space Reactors

Criticality and reactivity, control systems, shielding, cooling systems, fuels, auxiliaries, operation and performance, safety and radiation hazards, and economics, includes aircraft reactors

10.04 Process Heat and Desalination Reactors

Criticality and reactivity, control systems, shielding, cooling systems, fuels, auxiliaries, operation and performance, safety and radiation hazards, and economics

10.05 Research and Test Reactors and Critical Assemblies

Criticality and reactivity, control systems, shielding, cooling systems, fuels, auxiliaries, operation and performance, safety and radiation hazards, and irradiation facilities

Criticality studies not associated with a specific reactor

10.06 Production Reactors

Shielding, operation and performance, and safety and radiation hazards

10.07 Reactor Theory, Components, Fuels, and Accessories

(Where no type is specified)

11.0 GENERAL

Administrative reports on the management of fissionable and source materials, and those research and development reports from the United States Atomic Energy Commission and the national nuclear energy organizations of the United Kingdom, Canada, Sweden, Denmark, and Norway which have been made publicly available but which are outside the stated subject scope of other categories

Part 2

EXTENT OF INTEREST IN THE ELEMENTS

ACTINIUM

All scientific and technical aspects

ALUMINUM

Applications of the element or its alloys, compounds, or systems in nuclear technology or the behavior of the element, its alloys, compounds, or systems in an actual or a simulated reactor environment

Isotopes (excluding routine applications as tracers or radiation sources)

Metabolism, tissue distribution, and toxicology of radioisotopes

Nuclear properties and nuclear reactions

Radiation effects

Radiochemistry

AMERICIUM

All scientific and technical aspects

ANTIMONY

Applications of the element or its alloys, compounds, or systems in nuclear technology or the behavior of the element, its alloys, compounds, or systems in an actual or a simulated reactor environment

Isotopes (excluding routine applications as tracers or radiation sources)

Metabolism, tissue distribution, and toxicology of radioisotopes

Nuclear properties and nuclear reactions

Radiation effects

Radiochemistry

ARGON

Applications of the element in nuclear technology or the behavior of the element in an actual or a simulated reactor environment

Isotopes (excluding routine applications as tracers or radiation sources)

Metabolism, tissue distribution, and toxicology of radioisotopes

Nuclear properties and nuclear reactions

Radiation effects

Radiochemistry

ARSENIC

Applications of the element or its compounds or systems in nuclear technology or the behavior of the element, its compounds, or its systems in an actual or a simulated reactor environment

Isotopes (excluding routine applications as tracers or radiation sources)

Metabolism, tissue distribution, and toxicology of radioisotopes

Nuclear properties and nuclear reactions

Radiation effects

Radiochemistry

ASTATINE

All scientific and technical aspects

BARIUM

Applications of the element or its alloys, compounds, or systems in nuclear technology or the behavior of the element, its alloys, compounds, or systems in an actual or a simulated reactor environment

Isotopes (excluding routine applications as tracers or radiation sources)

Metabolism, tissue distribution, and toxicology

Nuclear properties and nuclear reactions

Radiation effects

Radiochemistry

BERKELIUM

All scientific and technical aspects

BERYLLIUM

Applications of the element or its alloys, compounds, or systems in nuclear technology or the behavior of the element, its alloys, compounds, or systems in an actual or a simulated reactor environment

Isotopes (excluding routine applications as tracers or radiation sources)

Metabolism, tissue distribution, and toxicology of radioisotopes

Metallurgy of the element or its alloys (steels containing this element are excluded unless the study concerns an actual or simulated nuclear application), compounds, or systems, excluding mineralogy

Nuclear properties and nuclear reactions

Radiation effects

Radiochemistry

BISMUTH

Applications of the element or its alloys, compounds, or systems in nuclear technology or the behavior of the element, its alloys, compounds, or systems in an actual or a simulated reactor environment

Isotopes (excluding routine applications as tracers or radiation sources)

Metabolism, tissue distribution, and toxicology of radioisotopes

Nuclear properties and nuclear reactions

Radiation effects

Radiochemistry

BORON

Applications of the element or its compounds or systems in nuclear technology or the behavior of the element, its compounds, or its systems in an actual or a simulated reactor environment

Isotopes (excluding routine applications as tracers or radiation sources)

Metabolism, tissue distribution, and toxicology of radioisotopes

Nuclear properties and nuclear reactions

Radiation effects

Radiochemistry

BROMINE

Applications of the element or its compounds or systems in nuclear technology or the behavior of the element, its compounds, or its systems in an actual or a simulated reactor environment

Isotopes (excluding routine applications as tracers or radiation sources)

Metabolism, tissue distribution, and toxicology of radioisotopes

Nuclear properties and nuclear reactions

Radiation effects

Radiochemistry

CADMIUM

Applications of the element or its alloys, compounds, or systems in nuclear technology or the behavior of the element, its alloys, compounds, or systems in an actual or a simulated reactor environment

Isotopes (excluding routine applications as tracers or radiation sources)

Metabolism, tissue distribution, and toxicology of radioisotopes

Nuclear properties and nuclear reactions

Radiation effects

Radiochemistry

CALCIUM

Applications of the element or its alloys, compounds, or systems in nuclear technology or the behavior of the element, its alloys, compounds, or systems in an actual or a simulated reactor environment

Isotopes (excluding routine applications as tracers or radiation sources)

Metabolism, tissue distribution, and toxicology of radioisotopes

Nuclear properties and nuclear reactions

Radiation effects

Radiochemistry

CALIFORNIUM

All scientific and technical aspects

CARBON

Applications of the element or its compounds or systems in nuclear technology or the behavior of the element, its compounds, or its systems in an actual or a simulated reactor environment

Isotopes (excluding routine applications as tracers or radiation sources)

Metabolism, tissue distribution, and toxicology of radioisotopes

Nuclear properties and nuclear reactions

Properties and fabrication of nuclear-grade graphite and graphite fuel materials

Radiation effects

Radiochemistry

CERIUM

Analysis, determination, and separation

Applications of the element or its alloys, compounds, or systems in nuclear technology or the behavior of the element, its alloys, compounds, or systems in an actual or a simulated reactor environment

Isotopes (excluding routine applications as tracers or radiation sources)

Metabolism, tissue distribution, and toxicology of radioisotopes

Metallurgy of the element or its alloys (steels containing this element are excluded unless the study concerns an actual or simulated nuclear application), compounds, or systems, excluding mineralogy

Nuclear properties and nuclear reactions

Radiation effects

Radiochemistry

CESIUM

Analysis, determination, and separation

Applications of the element or its alloys, compounds, or systems in nuclear technology or the behavior of the element, its alloys, compounds, or systems in an actual or a simulated reactor environment

Isotopes (excluding routine applications as tracers or radiation sources)

Metabolism, tissue distribution, and toxicology of radioisotopes

Nuclear properties and nuclear reactions

Radiation effects

Radiochemistry

CHLORINE

Applications of the element or its compounds or systems in nuclear technology or the behavior of the element, its compounds, or its systems in an actual or a simulated reactor environment

Isotopes (excluding routine application as tracers or radiation sources)

Metabolism, tissue distribution, and toxicology of radioisotopes

Nuclear properties and nuclear reactions

Radiation effects

Radiochemistry

CHROMIUM

Applications of the element or its alloys, compounds, or systems in nuclear technology or the behavior of the element, its alloys, compounds, or systems in an actual or a simulated reactor environment

Isotopes (excluding routine applications as tracers or radiation sources)

Metabolism, tissue distribution, and toxicology of radioisotopes

Nuclear properties and nuclear reactions

Radiation effects

Radiochemistry

COBALT

Applications of the element or its alloys, compounds, or systems in nuclear technology or the behavior of the element, its alloys, compounds, or systems in an actual or a simulated reactor environment

Isotopes (excluding routine applications as tracers or radiation sources)

Metabolism, tissue distribution, and toxicology of radioisotopes

Nuclear properties and nuclear reactions

Radiation effects

Radiochemistry

COPPER

Applications of the element or its alloys, compounds, or systems in nuclear technology or the behavior of the element, its alloys, compounds, or systems in an actual or a simulated reactor environment

Isotopes (excluding routine applications as tracers or radiation sources)

Metabolism, tissue distribution, and toxicology of radioisotopes
Nuclear properties and nuclear reactions
Radiation effects
Radiochemistry

CURIUM
All scientific and technical aspects

DYSPROSIUM
Analysis, determination, and separation
Applications of the element or its alloys, compounds, or systems in nuclear technology or the behavior of the element, its alloys, compounds, or systems in an actual or a simulated reactor environment
Isotopes (excluding routine applications as tracers or radiation sources)
Metabolism, tissue distribution, and toxicology of radioisotopes
Metallurgy of the element or its alloys (steels containing this element are excluded unless the study concerns an actual or simulated nuclear application), compounds, or systems, excluding mineralogy
Nuclear properties and nuclear reactions
Radiation effects
Radiochemistry

EINSTEINIUM
All scientific and technical aspects

ERBIUM
Analysis, determination, and separation
Applications of the element or its alloys, compounds, or systems in nuclear technology or the behavior of the element, its alloys, compounds, or systems in an actual or a simulated reactor environment
Isotopes (excluding routine applications as tracers or radiation sources)
Metabolism, tissue distribution, and toxicology of radioisotopes
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EUROPIUM
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Applications of the element or its alloys, compounds, or systems in nuclear technology or the behavior of the element, its alloys, compounds, or systems in an actual or a simulated reactor environment
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FERMIUM
All scientific and technical aspects

FLUORINE
Applications of the element or its compounds or systems in nuclear technology or the behavior of the element, its compounds, or its systems in an actual or a simulated reactor environment
Isotopes (excluding routine applications as tracers or radiation sources)
Metabolism, tissue distribution, and toxicology of radioisotopes
Nuclear properties and nuclear reactions
Radiation effects
Radiochemistry

FRANCIUM
All scientific and technical aspects

GADOLINIUM
Analysis, determination, and separation
Applications of the element or its alloys, compounds, or systems in nuclear technology or the behavior of the element, its alloys, compounds, or systems in an actual or a simulated reactor environment
Isotopes (excluding routine applications as tracers or radiation sources)
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GALLIUM
Applications of the element and its alloys, compounds, and systems in nuclear technology or the behavior of the element, its alloys, compounds, or systems in an actual or a simulated reactor environment
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GOLD
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Metabolism, tissue distribution, and toxicology of radioisotopes
Nuclear properties and nuclear reactions
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Radiochemistry

HAFNIUM

Applications of the element and its alloys, compounds, and systems in nuclear technology or the behavior of the element, its alloys, compounds, or systems in an actual or a simulated reactor environment

Isotopes (excluding routine applications as tracers or radiation sources)

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HELIUM

Applications of the element in nuclear technology or the behavior of the element in an actual or a simulated reactor environment

Isotopes (excluding routine applications as tracers or radiation sources)

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Nuclear properties and nuclear reactions

Radiation effects

Radiochemistry

HOLMIUM

Analysis, determination, and separation

Applications of the element or its alloys, compounds, or systems in nuclear technology or the behavior of the element, its alloys, compounds, or systems in an actual or a simulated reactor environment

Isotopes (excluding routine applications as tracers or radiation sources)

Metabolism, tissue distribution, and toxicology of radioisotopes

Metallurgy of the element or its alloys (steels containing this element are excluded unless the study concerns an actual or simulated nuclear application), compounds, or systems, excluding mineralogy

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HYDROGEN

Applications of the element or its compounds and systems in nuclear technology or the behavior of the element, its compounds, or its systems in an actual or a simulated reactor environment

Isotopes (excluding routine applications as tracers or radiation sources)

Metabolism, tissue distribution, and toxicology of deuterium and tritium

Nuclear properties and nuclear reactions

Radiation effects

Radiochemistry

INDIUM

Applications of the element and its alloys, compounds, and systems in nuclear technology or the behavior of the element, its alloys, compounds, or systems in an actual or a simulated reactor environment

Isotopes (excluding routine applications as tracers or radiation sources)

Metabolism, tissue distribution, and toxicology of radioisotopes

Nuclear properties and nuclear reactions

Radiation effects

Radiochemistry

IODINE

Analysis, determination, and separation

Applications of the element or its compounds or systems in nuclear technology or the behavior of the element, its compounds, or its systems in an actual or a simulated reactor environment

Isotopes (excluding routine applications as tracers or radiation sources)

Metabolism, tissue distribution, and toxicology

Nuclear properties and nuclear reactions

Radiation effects

Radiochemistry

IRIDIUM

Applications of the element or its alloys, compounds, or systems in nuclear technology or the behavior of the element, its alloys, compounds, or systems in an actual or a simulated reactor environment

Isotopes (excluding routine applications as tracers or radiation sources)

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Radiochemistry

IRON

Applications of the element and its alloys or systems, including steel and stainless steel, in nuclear technology or the behavior of the element, its alloys, or its systems in an actual or a simulated reactor environment

Isotopes (excluding routine applications as tracers or radiation sources)

Metabolism, tissue distribution, and toxicology of radioisotopes

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KRYPTON

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Applications of the element in nuclear technology or the behavior of the element in an actual or a simulated reactor environment

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LANTHANUM

Analysis, determination, and separation

Applications of the element or its alloys, compounds, or systems in nuclear technology or the behavior of the element, its alloys, compounds, or systems in an actual or a simulated reactor environment

Isotopes (excluding routine applications as tracers or radiation sources)

Metabolism, tissue distribution, and toxicology of radioisotopes

Metallurgy of the element or its alloys (steels containing this element are excluded unless the study concerns an actual or simulated nuclear application), compounds, or systems, excluding mineralogy

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LAWRENCIUM (103)
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Isotopes (excluding routine applications as tracers or radiation sources)
Metabolism, tissue distribution, and toxicology of radioisotopes
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Radiation effects
Radiochemistry

LITHIUM
Applications of the element or its alloys, compounds, or systems in nuclear technology or the behavior of the element, its alloys, compounds, or systems in an actual or a simulated reactor environment
Isotopes (excluding routine applications as tracers or radiation sources)
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LUTETIUM
Analysis, determination, and separation
Applications of the element or its alloys, compounds, or systems in nuclear technology or the behavior of the element, its alloys, compounds, or systems in an actual or a simulated reactor environment
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Applications of the element or its alloys, compounds, or systems in nuclear technology or the behavior of the element, its alloys, compounds, or systems in an actual or a simulated reactor environment
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MENDELEVIUM
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MERCURY
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YTTRIUM

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Appendix II

JOURNAL LIST

Journals from which articles have been abstracted and indexed in NSA are listed here alphabetically by title abbreviation. With few exceptions, NSA uses title abbreviations as approved by the United States of America Standards Institute.

Titles of journals that are scanned regularly for NSA are marked by an asterisk (*). English translations are available for those foreign-language journals identified by a dagger (†). Original-language titles for translated journals are given in parentheses after the English titles.

Abh. Deut. Akad. Wiss. Berlin, Kl. Chem., Geol. Biol.
Abhandlungen der Deutschen Akademie der Wissenschaften zu Berlin, Klasse fuer Chemie, Geologie und Biologie *(Germany)*

Abh. Deut. Akad. Wiss. Berlin, Kl. Med.
Abhandlungen der Deutschen Akademie der Wissenschaften zu Berlin, Klasse fuer Medizin *(East Germany)*

Abstr. Bulg. Sci. Lit., Math., Phys., Astron., Geophys., Geod.
*Abstracts of Bulgarian Scientific Literature, Mathematics, Physics, Astronomy, Geophysics, Geodesy *(Bulgaria)*

Acad. Repub. Pop. Rom., Stud. Cercet. Biochim.
Academia Republicii Populare Romine, Institutul de Biochemie, Studii si Cercetari de Biochimie *(Romania)*

Acad. Repub. Pop. Rom., Stud. Cercet. Fiz.
Academia Republicii Populare Romine, Institutul de Fizica Atomica si Institutul de Fizica, Studii si Cercetari de Fizica *(Romania)*

Acad. Repub. Pop. Rom., Stud. Cercet. Fiziol.
Academia Republicii Populare Romine, Institutul de Fiziologie Normala si Patologica "Dr. D. Danielopolu," Studii si Cercetari de Fiziologie *(Romania)*

ACEC (Ateliers Constr. Elec. Charleroi) Rev.
*ACEC (Ateliers de Constructions Electriques de Charleroi) Reviews *(Belgium)*

Acqua Ind.
Acqua Industriale *(Italy)*

Acta Agron. Acad. Sci. Hung.
Acta Agronomica Academiae Scientiarum Hungaricae *(Hungary)*

Acta Allergol.
*Acta Allergologica *(Denmark)*

Acta Allergol., Suppl.
*Acta Allergologica, Supplementum *(Denmark)*

Acta Anaesth. Scand.
*Acta Anaesthesiologica Scandinavica *(Denmark)*

Acta Anat.
*Acta Anatomica *(Switzerland)*

Acta Anat., Suppl.
*Acta Anatomica, Supplementum *(Switzerland)*

Acta Anat. Sinica
Acta Anatomica Sinica
see **Chieh Pou Hsueh Pao**

Acta Automat. Sinica
Acta Automatica Sinica
see **Tzu Tung Hua Hsueh Pao**

Acta Biochim. Biophys.
Acta Biochimica et Biophysica *(Hungary)*

Acta Biochim. Biophys. Sinica
Acta Biochimica et Biophysica Sinica
see **Sheng Wu Hua Hsueh Yu Shing Wu Wu Li Hsueh Pao**

Acta Biochim. Pol.
Acta Biochimica Polonica *(Poland)*

Acta Biochim. Pol. (Engl. Transl.)
*Acta Biochimica Polonica (English Translation) *(Poland)*

Acta Biochim. Sinica
Acta Biochimica Sinica
see **Sheng Li Hsueh Pao**

Acta Biol. Acad. Sci. Hung.
*Acta Biologica Academiae Scientiarum Hungaricae *(Hungary)*

Acta Biol. Cracov., Ser. Zool.
Acta Biologica Cracoviensia, Serie Zoologie *(Poland)*

Acta Biol. Exp. Sinica
Acta Biologiae Experimentalis Sinica
see **Shih Yen Sheng Wu Hsueh Pao**

Acta Biol. Med. Ger.
*Acta Biologica et Medica Germanica *(Germany)*

Acta Bot. Acad. Sci. Hung.
Acta Botanica Academiae Scientiarum Hungaricae *(Hungary)*

Acta Chem. Scand.
*Acta Chemica Scandinavica *(Denmark)*

Acta Chim. Acad. Sci. Hung.
*Acta Chimica Academiae Scientiarum Hungaricae *(Hungary)*

Acta Chim. Sinica
Acta Chimica Sinica
see **Hua Hsueh Hsueh Pao**

Acta Chir. Acad. Sci. Hung.
*Acta Chirurgica Academiae Scientiarum Hungaricae *(Hungary)*

Acta Chir. Scand.
Acta Chirurgica Scandinavica *(Sweden)*

Acta Cient. Venezol.
*Acta Cientifica Venezolana *(Venezuela)*

Acta Crystallogr.
*Acta Crystallographica *(Denmark)*

Acta Cytol.
*Acta Cytologica *(U. S.)*

Acta Dermato-Venereol.
*Acta Dermato-Venereologica *(Sweden)*

Acta Endocrinol.
*Acta Endocrinologica *(Denmark)*

Acta Endocrinol., Suppl.
*Acta Endocrinologica, Supplementum *(Denmark)*

Acta Gastro-Enterol. Belg.
Acta Gastro-Enterologica Belgica *(Belgium)*

Acta Genet. Med. Gemellol.
*Acta Geneticae Medicae et Gemellologiae *(Italy)*

Acta Genet. Statist. Med.
*Acta Genetica et Statistica Medica *(Switzerland)*

Acta Geophys. Pol.
Acta Geophysica Polonica *(Poland)*

Acta Gerontol.
*Acta Gerontologica *(Italy)*

Acta Gynaecol. Obstet. Hispano Lusitana
Acta Gynaecologica et Obstetrica Hispano Lusitana *(Portugal)*

Acta Haematol.
*Acta Haematologica; International Journal of Hematology *(Switzerland)*

Acta Haematol. Jap.
Acta Haematologica Japonica

see Nippon Katsueki Gakkai Zasshi
Acta Hepato-Splenol.
*Acta Hepato-Splenologica (West Germany)
Acta Histochem.
*Acta Histochemica (Germany)
Acta Hydrobiol.
Acta Hydrobiologica, Polska Akademia Nauk, Zaklad Biologii Wod (Poland)
Acta IMEKO
*Acta IMEKO (Hungary)
Acta Isotop.
*Acta Isotopica (Italy)
Acta Math.
*Acta Mathematica (Hungary)
Acta Med. (Fukouka)
Acta Medica (Fukouka)
see Igaku Kenkyu
Acta Med. Acad. Sci. Hung.
*Acta Medica Academiae Scientiarum Hungaricae (Hungary)
Acta Med. Biol. (Niigata)
*Acta Medica et Biologica (Niigata) (Japan)
Acta Med. Hidalg.
Acta Medica Hidalguense (Mexico)
Acta Med. Iran.
Acta Medica Iranica (Iran)
Acta Med. Okayama
Acta Medicinae Okayama (Japan)
Acta Med. Nagasaki.
Acta Medica Nagasakiensia (Japan)
Acta Med. Philippina
Acta Medica Philippina (Philippines)
Acta Med. Pol.
*Acta Medica Polona (Poland)
Acta Med. Scand.
*Acta Medica Scandinavica (Sweden)
Acta Med. Scand., Suppl.
*Acta Medica Scandinavica, Supplement (Sweden)
Acta Met.
*Acta Metallurgica (U. S.)
Acta Met. Sinica
Acta Metallurgica Sinica
see Chin Shu Hsueh Pao
Acta Microbiol. Acad. Sci. Hung.
*Acta Microbiologica Academiae Scientiarum Hungaricae (Hungary)
Acta Microbiol. Pol.
*Acta Microbiologica Polonica (Poland)
Acta Microbiol. Sinica
Acta Microbiologica Sinica
see Wei Sheng Wu Hsueh Pao
Acta Morphol. Acad. Sci. Hung.
*Acta Morphologica Academiae Scientiarum Hungaricae (Hungary)
Acta Morphol. Neer.-Scand.
*Acta Morphological Neerlando-Scandinavica (Netherlands)
Acta Neurochir.
Acta Neurochirurgica (Austria)
Acta Neurol. Latinoamer.
Acta Neurologia Latinoamericana (Uruguay)
Acta Neurol. Scand.
*Acta Neurologica Scandinavica (Denmark)
Acta Neurol. Scand., Suppl.
*Acta Neurologica Scandinavica, Supplementum (Denmark)
Acta Neuropathol.
Acta Neuropathologica (Germany)
Acta Neuropsiquiat. Argent.
Acta Neuropsiquiatrica Argentina (Argentina)
Acta Obstet. Gynecol. Scand.
*Acta Obstetricia et Gynecologica Scandinavica (Sweden)
Acta Obstet. Gynecol. Scand., Suppl.
*Acta Obstetricia et Gynecologica Scandinavica, Supplement (Sweden)
Acta Oncol.
Acta Oncologica (Spain)
Acta Ophthalmol.
*Acta Ophthalmologica (Denmark)
Acta Ophthalmol., Suppl.
*Acta Ophthalmologica, Supplementum (Denmark)
Acta Orthop. Scand.
*Acta Orthopaedica Scandinavica (Denmark)
Acta Orthop. Scand., Suppl.
*Acta Orthopaedica Scandinavica, Supplementum (Denmark)
Acta Oto-Laryngol.
Acta Oto-Laryngologica (Sweden)
Acta Oto-Laryngol., Suppl.
Acta Oto-Laryngologica, Supplementum (Sweden)
Acta Paediat.
*Acta Paediatrica (Sweden)
Acta Paediat. Acad. Sci. Hung.
*Acta Paediatrica Academiae Scientiarum Hungaricae (Hungary)
Acta Pathol. Jap.
*Acta Pathologica Japonica (Japan)
Acta Pathol. Microbiol. Scand.
*Acta Pathologica et Microbiologica Scandinavica (Denmark)
Acta Pathol. Microbiol. Scand., Suppl.
*Acta Pathologica et Microbiologica Scandinavica, Supplementum (Denmark)
Acta Pharm. Sinica
Acta Pharmaceutica Sinica
see Yao Hsueh Hsueh Pao
Acta Phytophysiol. Sinica
Acta Phytophysiologica Sinica
see Chih Wu Sheng Li Hsueh Pao
Acta Pharm. Jugoslav.
Acta Pharmaceutica Jugoslavica (Yugoslavia)
Acta Pharm. Toxicol.
*Acta Pharmacologica et Toxicologica (Denmark)
Acta Pharm. Toxicol., Suppl.
*Acta Pharmacologica et Toxicologica, Supplementum (Denmark)
Acta Phys. Acad. Sci. Hung.
*Acta Physica Academiae Scientiarum Hungaricae (Hungary)
Acta Phys. Austr.
*Acta Physica Austriaca (Austria)
Acta Phys. Austr., Suppl.
*Acta Physica Austriaca, Supplementum (Austria)
Acta Phys. Chim. Debrecina
Acta Physica et Chimica Debrecina (Hungary)
Acta Physiol. Acad. Sci. Hung.
*Acta Physiologica Academiae Scientiarum Hungaricae (Hungary)
Acta Physiol. Latinoamer.
*Acta Physiologica Latinoamericana (Argentina)
Acta Physiol. Pharmacol. Neer.
*Acta Physiologica et Pharmacologica Neerlandica (Netherlands)
Acta Physiol. Pol.
*Acta Physiologica Polonica (Poland)
Acta Physiol. Scand.
*Acta Physiologica Scandinavica (Sweden)
Acta Physiol. Scand., Suppl.
*Acta Physiologica Scandinavica, Supplementum (Sweden)
Acta Phys. Pol.
*Acta Physica Polonica (Poland)
Acta Phys. Sinica
Acta Physica Sinica
see Wu Li Hsueh Pao
Acta Pol. Pharm.
Acta Poloniae Pharmaceutica (Poland)
Acta Polytech. Scand., Chem. Met. Ser.
*Acta Polytechnica Scandinavica, Chemistry including Metallurgy Series (Sweden)
Acta Polytech. Scand., Civil Eng. Bldg. Constr. Ser.
*Acta Polytechnica Scandinavica, Civil Engineering and Building Construction Series (Sweden)
Acta Polytech. Scand., Elec. Eng. Ser.
*Acta Polytechnica Scandinavica, Electrical Engineering Series (Sweden)
Acta Polytech. Scand., Math. Comput. Mach. Ser.
*Acta Polytechnica Scandinavica, Mathematics and Computing Machinery Series (Sweden)
Acta Polytech. Scand., Mech. Eng. Ser.
*Acta Polytechnica Scandinavica, Mechanical Engineering Series (Sweden)
Acta Polytech. Scand., Phys. Nucl. Ser.
*Acta Polytechnica Scandinavica, Physics Including Nucleonics Series (Sweden)
Acta Psychiat. Scand.
Acta Psychiatrica Scandinavica (Denmark)
Acta Psychiat. Scand., Suppl.
Acta Psychiatrica Scandinavica, Supplementum (Denmark)
Acta Radiol., Diagn.
*Acta Radiologica, Diagnosis (Sweden)
Acta Radiol., Suppl.

*Acta Radiologica, Supplementum *(Sweden)*
Acta Radiol., Ther., Phys., Biol.
*Acta Radiologica, Therapy, Physics, Biology *(Sweden)*
Acta Rheum. Scand.
Acta Rheumatologica Scandinavica *(Sweden)*
Actas Dermo-Sifiliog.
Actas Dermo-Sifiliograficas *(Spain)*
Acta Soc. Bot. Pol.
Acta Societatis Botanicorum Poloniae *(Poland)*
Acta Soc. Med. Upsal.
*Acta Societatis Medicorum Upsaliensis *(Sweden)*
Acta Tech. Acad. Sci. Hung.
Acta Technica Academiae Scientiarum Hungaricae *(Hungary)*
Acta Tech. CSAV
Acta Technica CSAV (Ceskoslovenska Akademia Ved) (formerly Acta Technica (Prague)) *(Czechoslovakia)*
Acta Tuberc. Pneumol. Scand.
Acta Tuberculosea et Pneumologica Scandinavica *(Denmark)*
Acta Tuberc. Pneumol. Scand., Suppl.
Acta Tuberculosea et Pneumologica Scandinavica, Supplementum *(Denmark)*
Acta Univ. Carolinae. Med.
*Acta Universitatis Carolinae, Medica *(Czechoslovakia)*
Acta Univ. Carolinae, Med., Suppl.
Acta Universitatis Carolinae, Medica, Supplementum *(Czechoslovakia)*
Acta Univ. Szeged. Acta Phys. Chem.
*Acta Universitatis Szegediensis, Acta Physica et Chemica *(Hungary)*
Acta Urol. Jap.
Acta Urological Japonica
see Hinyokika Kiyo
Acta Vet. (Belgrade)
*Acta Veterinaria (Belgrade) *(Yugoslavia)*
Acta Vet. Acad. Sci. Hung.
*Acta Veterinaria Academiae Scientiarum Hungaricae *(Hungary)*
Acta Vet. Scand.
Acta Veterinaria Scandinavica *(Denmark)*
Acta Vet. Scand., Suppl.
Acta Veterinaria Scandinavica, Supplementum *(Denmark)*
Acta Virol. (Prague)
*Acta Virologica (Prague) *(Czechoslovakia)*
Acta Vitaminol.
*Acta Vitaminologica *(Italy)*
Acta Zool. Acad. Sci. Hung.
*Acta Zoologica Academiae Scientiarum Hungaricae *(Hungary)*
Acta Zool. Sinica
Acta Zoological Sinica
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Actinides Rev.
*Actinides Reviews *(Netherlands)*
Activ. Nerv. Super.
*Activitas Nervosa Superior *(Czechoslovakia)*
Actual. Odonto-Stomatol.
Actualites Odonto-Stomatologiques *(France)*
Acustica
*Acustica. International Journal for Acoustics *(West Germany)*
Adhesion Adhesives
Adhesion and Adhesives
see Setchaku
Adhesives Age
Adhesives Age *(U. S.)*
Advan. Anal. Chem. Instrum.
*Advances in Analytical Chemistry and Instrumentation *(U. S.)*
Advan. Appl. Mech.
Advances in Applied Mechanics *(U. S.)*
Advan. Appl. Microbiol.
Advances in Applied Microbiology *(U. S.)*
Advan. Astron. Astrophys.
*Advances in Astronomy and Astrophysics *(U. S.–England)*
Advan. Astronaut. Sci.
Advances in Astronautical Sciences *(U. S.)*
Advan. At. Mol. Phys.
*Advances in Atomic and Molecular Physics *(U. S.)*
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*Advances in Cancer Research *(U. S.)*
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*Advances in Chemical Engineering *(U. S.)*
Advan. Chem. Phys.
*Advances in Chemical Physics *(England)*
Advan. Chem. Ser.
*Advances in Chemistry Series *(U. S.)*
Advan. Comp. Physiol. Biochem.
*Advances in Comparative Physiology and Biochemistry *(U. S.)*
Advan. Electron. Electron Phys.
*Advances in Electronics and Electron Physics *(U. S.)*
Advan. Energy Conversion
*Advanced Energy Conversion *(England)*
Advan. Fluorine Chem.
*Advances in Fluorine Chemistry *(U. S.)*
Advan. Food Res.
*Advances in Food Research *(U. S.)*
Advan. Frontiers Plant Sci.
Advancing Frontiers of Plant Sciences *(India)*
Advan. Genet.
*Advances in Genetics *(U. S.)*
Advan. Geophys.
*Advances in Geophysics *(U. S.)*
Advan. Heat Transfer
*Advances in Heat Transfer *(U. S.)*
Advan. Inorg. Chem. Radiochem.
*Advances in Inorganic Chemistry and Radiochemistry *(U. S.–England)*
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Advances in Internal Medicine *(U. S.)*
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*Advances in Nuclear Science and Technology *(U. S.)*
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Advances in Obstetrics and Gynaecology
see Sanfujinka no Shimpo
Advan. Ophthamol.
Advances in Ophthalmology
see Documenta Ophthalmologica.
Advan. Organometal. Chem.
*Advances in Organometallic Chemistry *(U. S.)*
Advan. Org. Chem.
*Advances in Organic Chemistry: Methods and Results *(U. S.)*
Advan. Photochem.
*Advances in Photochemistry *(U. S.)*
Advan. Phys.
*Advances in Physics *(England)*
Advan. Phys. Org. Chem.
*Advances in Physical Organic Chemistry *(U. S.)*
Advan. Radiat. Biol.
*Advances in Radiation Biology *(U. S.)*
Advan. Sci.
Advancement of Science, The *(England)*
Advan. Space Sci. Technol.
*Advances in Space Science and Technology *(U.S.)*
Advan. Spectrosc.
*Advance in Spectroscopy *(U. S.)*
Advan. Struct. Res. Diffr. Methods
*Advances in Structure Research by Diffraction Methods *(U. S.–Germany)*
Advan. Tracer Methodol.
*Advances in Tracer Methodology *(U. S.)*
Advan. Vet. Sci.
Advances in Veterinary Science *(U. S.)*
Advan. Virus Res.
Advances in Virus Research *(U. S.–England)*
Advan. Waste Treat. Res.
*Advances in Waste Treatment Research *(U. S.)*
A E G Mitt.
*A E G Mitteilungen *(Germany)*
AEI (Ass. Elec. Ind.) Eng.
*AEI (Associated Electrical Industries) Engineering *(England)*
Aeronaut. Quart.
*Aeronautical Quarterly *(England)*
Aerosp. Med.
*Aerospace Medicine (formerly The Journal of Aviation Medicine) *(U. S.)*
Aerosp. Technol.
Aerospace Technology *(U. S.)*
Aerotecnica
*Aerotecnica, L. *(Italy)*
Aerztl. Forsch.
Aerztliche Forschung *(Germany)*
Afinidad
*Afinidad *(Spain)*
Aggiorn. Mal. Infez.
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Agr. Biol. Chem. (Tokyo)
Agricultural and Biological Chemistry (Tokyo) *(Japan)*
Agressologie
*Agressologie. Revue Internationale de Physio-Biologie et de Pharmacologie Appliquees aux Effects de l'Agression *(France)*
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*Agri Hortique Genetica *(Sweden)*
Agrobiologiya
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Agrokemia Talajtan
*Agrokemia es Talajtan *(Hungary)*
Agrokhimiya
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Agron. J.
Agronomy Journal *(U. S.)*
Agron. Lusitana
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Agr. Res. (U. S.)
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AIAA (Amer. Inst. Aeronaut. Astronaut.) J.
*AIAA (American Institute of Aeronautics and Astronautics) Journal (combining the ARS Journal and the Journal of Aerospace Sciences) *(U. S.)*
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Aircraft Eng.
*Aircraft Engineering *(England)*
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Akademiya Nauk Ukrain'skoi RSR, Institut Teploenergetiki, Zbirnik Prats *(Ukrainian S.S.R.)*
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*American Ceramic Society Bulletin, The *(U. S.)*
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*American Industrial Hygiene Association Journal *(U. S.)*
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*American Journal of Anatomy, The *(U.S.)*
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*American Journal of Botany *(U. S.)*
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*American Journal of Clinical Nutrition, The *(U.S.)*
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Amer. J. Dig. Dis.
*American Journal of Digestive Diseases, The *(U. S.)*
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*American Journal of Epidemiology *(U.S.)*
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*American Journal of Gastroenterology, The *(U.S.)*
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*American Journal of Human Genetics, The *(U. S.)*
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*American Journal of Medicine, The *(U.S.)*
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Amer. J. Med. Sci.
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*American Journal of Obstetrics and Gynecology *(U. S.)*
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*American Journal of Orthodontics *(U.S.)*
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*American Journal of Pharmaceutical Education *(U.S.)*
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*American Journal of Physics *(U. S.)*
Amer. J. Phys. Anthropol.
*American Journal of Physical Anthropology *(U.S.)*
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*American Journal of Physiology, The *(U. S.)*
Amer. J. Phys. Med.
*American Journal of Physical Medicine *(U. S.)*
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*American Journal of Psychology, The *(U. S.)*
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*American Journal of Science *(U. S.)*
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*American Journal of Surgery, The *(U. S.)*
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*American Journal of Tropical Medicine and Hygiene *(U. S.)*
Amer. J. Vet. Res.
*American Journal of Veterinary Research *(U. S.)*
Amer. Math. Mon.
*American Mathematical Monthly *(U.S.)*
Amer. Midland Natur.
American Midland Naturalist *(U. S.)*
Amer. Mineral.
*American Mineralogist, The *(U. S.)*
Amer. Natur.
*American Naturalist *(U. S.)*
Amer. Potato J.
American Potato Journal *(U. S.)*
Amer. Rev. Respirat. Dis.
*American Review of Respiratory Diseases *(U. S.)*
Amer. Sci.
*American Scientist *(U.S.)*
Amer. Soc. Metals, Trans. Quart.
*American Society for Metals, Transactions Quarterly *(U. S.)*

Amer. Surg.
American Surgeon *(U. S.)*
Amer. Zool.
*American Zoologist *(U.S.)*
An. Acad. Brasil. Cienc.
*Anais da Academia Brasileira de Ciencias *(Brazil)*
Anaesthesia
*Anaesthesia *(England)*
Anal. Abstr.
*Analytical Abstracts *(England)*
Anal. Biochem.
*Analytical Biochemistry *(U. S.)*
Anal. Chem.
*Analytical Chemistry *(U. S.)*
Anal. Chim. Acta
*Analytica Chimica Acta *(Netherlands)*
Analyst
*Analyst, The *(England)*
Anat. Rec.
*Anatomical Record, The *(U.S.)*
An. Brasil. Dermatol. Sifilog.
Anais Brasileiros de Dermatologia e Sifilografia *(Brazil)*
An. Brasil. Ginecol. (Rio de Janeiro)
Anais Brasileiros de Ginecologia (Rio de Janeiro) *(Brazil)*
An. Edafol. Agrobiol. (Madrid)
Anales de Edafologia y Agrobiologia (Madrid) *(Spain)*
Anesth. Analg., Curr. Res.
*Anesthesia and Analgesia; Current Researches *(U.S.)*
Anesth., Analg., Reanimation
*Anesthesie, Analgesie, Reanimation *(France)*
Anesthesiology
*Anesthesiology *(U.S.)*
Angew. Chem.
Angewandte Chemie *(West Germany)*
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*Angewandte Chemie. International Edition in English *(U. S.—Germany)*
Angiologia (Barcelona)
*Angiologia (Barcelona) *(Spain)*
Angiology
*Angiology *(U. S.)*
Anglo-German Med. Rev.
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An. Hosp. Mil. Cent. (Lima, Peru)
Anales del Hospital Militar Central (Lima, Peru) *(Peru)*
Anim. Behav.
*Animal Behaviour *(England)*
An. Inst. Cercet. Pentru Cereale Plante Teh.-Fundulea, Ser. C
Analele Institutului de Cercetari Pentru Cereale si Plante Tehnice-Fundulea, Institutul Central de Cercetari Agricole, Consiliul Superior al Agriculturii, Seria C *(Romania)*
An. Inst. Corachan (Barcelona)
Anales del Instituto Corachan (Barcelona) *(Spain)*
An. Inst. Med. Trop. (Lisbon)
Anais Instituto de Medicina Tropical (Lisbon) *(Portugal)*
An. Inst. Oncol. "Angel H. Roffo"
Anales del Instituto de Oncologia "Angel H. Roffo" *(Argentina)*
An. Med. Cir.
Anales de Medicina y Cirugia *(Spain)*
An. Med., Soc. Med.
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Ann. Acad. Sci. Fenn., Ser. A VI
*Annales Academiae Scientiarum Fennicae, Series A VI. Physica *(Finland)*
Ann. Agron., Hors-Ser.
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Ann. Allergy
*Annals of Allergy *(U. S.)*
Ann. Anat. Pathol.
Annales d'Anatomie Pathologique *(France)*
Ann. Appl. Biol.
*Annals of Applied Biology, The *(England)*
Ann. Astrophys.
*Annales d'Astrophysique *(France)*
Ann. Biochem. Exp. Med. (Calcutta)
Annals of Biochemistry and Experimental Medicine (Calcutta) *(India)*
Ann. Biol. Anim., Biochim., Biophys.
*Annales de Biologie Animale, Biochimie, Biophysique *(France)*
Ann. Biol. Clin. (Paris)
*Annales de Biologie Clinique (Paris) *(France)*
Ann. Bot. (London)
*Annals of Botany (London) *(England)*
Ann. Chem.
*Annalen der Chemie, Justus Liebias *(Germany)*
Ann. Chim. (Paris)
*Annales de Chimie (Paris) *(France)*
Ann. Chim. (Rome)
*Annali di Chimica (Rome) *(Italy)*
Ann. Chir. Gynaecol. Fenn.
Annales Chirurgiae et Gynaecologiae Fenniae *(Finland)*
Ann. Chir. Plastique, Semaine Hop.
Annales de Chirurgie Plastique, Archives de la Ste Francaise de Chirurgie Plastique et Reconstructive, La Semaine des Hopitaux *(France)*
Ann. Endocrinol. (Paris)
*Annales d'Endocrinologie (Paris) *(France)*
Ann. Entomol. Soc. Amer.
Annals of the Entomological Society of America *(U. S.)*
Ann. Fals. Expert. Chim.
Annales des Falsifications et de l'Expertise Chimique *(France)*
Ann. Gembloux
Annales de Gembloux *(Belgium)*
Ann. Genet.
*Annales de Genetique *(France)*
Ann. Geofis. (Rome)
Annali di Geofisica (Rome) *(Italy)*
Ann. Geophys.
*Annales de Geophysique *(France)*
Ann. Histochim.
Annales d'Histochimie *(France)*
Ann. Human Genet.
*Annales of Human Genetics *(England)*
Ann. Inst. Henri Poincare
Annales de l'Institut Henri Poincare *(France)*
Ann. Inst. Henri Poincare, Sect. A
*Annales de l'Institut Henri Poincare, Section A. Physique Theorique *(France)*
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*Annales de l'Institut Henri Poincare, Section B. Calcul des Probilities et Statistique *(France)*
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*Annales de l'Institut Pasteur *(France)*
Ann. Inst. Tech. Batiment Trav. Publics
Annales de l'Institut Technique du Batiment et des Travaux Publics *(France)*
Ann. Intern. Med.
*Annals of Internal Medicine *(U. S.)*
Ann. Int. Geophys. Year
*Annals of the International Geophysical Year *(England)*
Ann. Ist. Super. Sanita
*Annali dell'Istituto Superiore di Sanita *(Italy)*
Ann. Ital. Dermatol. Clin. Sper.
Annali Italiani di Dermatologia Clinica e Sperimentale *(Italy)*
Ann. Math.
*Annals of Mathematics *(U.S.)*
Ann. Math. Statist.
*Annals of Mathematical Statistics *(U.S.)*
Ann. Med. Exp. Biol. Fenn. (Helsinki)
*Annales Medicinae Experimentalis et Biologiae Fenniae (Helsinki) *(Finland)*
Ann. Med. Intern. Fenn.
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Ann. Med. Nav.
Annali di Medicina Navale *(Italy)*
Ann. Mines
Annales des Mines *(France)*
Ann. Nutr. Aliment.
*Annales de la Nutrition et de l'Alimentation *(France)*
Ann. N. Y. Acad. Sci.
*Annals of the New York Academy of Sciences *(U. S.)*
Ann. Occup. Hyg.
*Annals of Occupational Hygiene *(England)*
Ann. Occup. Hyg., Suppl.
*Annals of Occupational Hygiene, The, Supplement *(England)*
Ann. Ocul. (Paris)
Annales d'Oculistique (Paris) *(France)*
Ann. Odonto-Stomatol.
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Ann. Ostet. Ginecol.
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Ann. Otol. Rhinol. Laryngol.

*Annals of Otology, Rhinology, and Laryngology *(U.S.)*
Ann. Ottalmol. Clin. Oculist.
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Annot. Zool. Jap.
Annotationes Zoologicae Japonenses *(Japan)*
Ann. Paediat.
*Annales Paediatrici *(Switzerland)*
Ann. Paediat. Fenn.
Annales Paediatriae Fenniae *(Finland)*
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*Annales Pharmaceutiques Francaises *(France)*
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*Annals of Physics (New York) *(U. S.)*
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*Annales de Physique (Paris) *(France)*
Ann. Physiol. Veg.
Annales de Physiologie Vegetale *(France)*
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Annales de Physiologie Vegetale de l'Universite de Bruxelles *(Belgium)*
Ann. Phytopathol. Soc. Jap.
Annals of the Phytopathological Society of Japan
*see **Nippon Shokubutsu Byori Gakkaiho***
Ann. Radioelec.
*Annales de Radioelectricite *(France)*
Ann. Radiol.
*Annales de Radiologie *(France)*
Ann. Radiol. Diagn.
Annali di Radiologia Diagnostica *(Italy)*
Ann. Rep. Jap. Ass. Radiat. Res. Polym.
Annual Report of the Japanese Association for Radiation Research on Polymers
*see **Nippon Hoshasen Kobunshi Kenkyu Kyokai Nempo***
Ann. Rep. Nat. Inst. Genet. (Misima, Jap.)
Annual Report of the National Institute of Genetics (Misima, Japan) *(Japan)*
Ann. Rheum. Dis.
*Annals of the Rheumatic Diseases *(England)*
Ann. Roy. Coll. Surg. Engl.
Annals of the Royal College of Surgeons of England *(England)*
Ann. Sclavo
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Ann. Soc. Sci. Brux. Ser. I
*Annales de la Societe Scientifique de Bruxelles. Serie I *(Belgium)*
Ann. Surg.
*Annals of Surgery *(U. S.)*
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Ann. Thorac. Surg.
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Annu. Rep. Eng. Res. Inst., Univ. Tokyo
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*see **Sogo Shikensho Nempo***
Annu. Rep. Inst. Virus Res., Kyoto Univ.
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Annu. Rep. Progr. Chem. (Chem. Soc. London)
*Annual Reports on the Progress of Chemistry (Chemical Society of London) *(England)*
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*Annual Report of the Radiation Center of Osaka Prefecture *(Japan)*
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*Annual Report of Scientific Works, Faculty of Science, Osaka University *(Japan)*
Annu. Rev. Astron. Astrophys.
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*Annual Review of Entomology *(U.S.)*
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*Annual Review of Medicine *(U. S.)*
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*Annual Review of Physical Chemistry *(U. S.)*
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An. Real Acad. Nacl. Med. (Madrid)
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An. Real Soc. Espan. Fis. Quim. (Madrid), Ser. A
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*Anales de la Real Sociedad Espanola de Fisica y Quimica (Madrid), Serie B *(Spain)*
An. Soc. Cient. Argent.
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An. Stiint. Univ. "Al. I. Cuza", Iasi, Sect. II, a
Analele Stiintifice ale Universitatii "Al. I. Cuza", din Iasi, Sectiunea II, a. Biologie *(Romania)*
Antarctic J. U. S.
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*Antibiotica et Chemotherapia *(Switzerland)*
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*Antonie van Leeuwenhoek, Journal of Microbiology and Serology *(Netherlands)*
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APL (Appl. Phys. Lab.) Tech. Dig.
APL (Applied Physics Laboratory) Technical Digest *(U. S.)*
Appl. Biochem. Microbiol. (USSR) (Engl. Transl.)
Applied Biochemistry and Microbiology (USSR) (English Translation of Prikladnaya Biokhimiya i Mikrobiologiya) *(U. S.)*
Appl. Mater. Res.
*Applied Materials Research *(England)*
Appl. Mech. Rev.
*Applied Mechanics Reviews *(U. S.)*
Appl. Microbiol.
*Applied Microbiology *(U. S.)*
Appl. Opt.
*Applied Optics *(U. S.)*
Appl. Phys. Lett.
*Applied Physics Letters *(U. S.)*
Appl. Sci. Res. (The Hague)
*Applied Scientific Research (The Hague) (formed by the merger of Sections A and B) *(Netherlands)*
Appl. Sci. Res., Sect. A

Applied Scientific Research, Section A *(Netherlands)*
Appl. Sci. Res., Sect. B
Applied Scientific Research, Section B *(Netherlands)*
Appl. Spectrosc.
*Applied Spectroscopy *(U. S.)*
Arbok Univ. Bergen, Mat.-Natur. Ser.
*Arbok for Universitetet i Bergen, Matematikk-Naturvitenskap Serie *(Norway)*
Arch. Anat. Microscop. Morphol. Exp.
*Archives d'Anatomie Microscopique et de Morphologie Experimentale *(France)*
Arch. Anat. Pathol., Sem. Hop.
Archives d'Anatomie Pathologique, La Semaine de Hopitaux *(France)*
Arch. Automat. Telemech.
Archiwum Automatyki i Telemechaniki *(Poland)*
Arch. Belg. Dermatol. Syphiligr.
Archives Belges de Dermatologie et de Syphiligraphie *(Belgium)*
Arch. Biochem. Biophys.
*Archives of Biochemistry and Biophysics *(U. S.)*
Arch. Biol. (Liege)
Archives de Biologie (Liege) *(Belgium)*
Arch. Biol. Med. Exp.
*Archivos de Biologia y Medicina Experimentales. Organ de la Sociedad de Biologia de Santiago *(Chile)*
Arch. Bioquim., Quim. Farm. Tucuman
Archivos de Bioquimica, Quimica y Farmacia, Tucuman *(Argentina)*
Arch. Bodowy Maszyn
Archiwum Bodowy Maszyn *(Poland)*
Arch. Dermatol.
*Archives of Dermatology (formerly A.M.A. Archives of Dermatology) *(U. S.)*
Arch. "De Vecchi" Anat. Patol. Med. Clin.
Archivio "De Vecchi" per l'Anatomia Patologica e la Medicina Clinica *(Italy)*
Arch. Dis. Childhood
*Archives of Disease in Childhood *(England)*
Arch. Eisenhuettenw.
*Archiv fuer das Eisenhuettenwesen *(Germany)*
Arch. Elektrotech. (Berlin)
*Archiv fuer Elektrotechnik *(Germany)*
Arch. Elektrotech. (Warsaw)
*Archiwum Elektrotechniki (Warsaw) *(Poland)*
Arch. Elek. Uebertr.
*Archiv der Elektrischen Uebertragung *(Germany)*
Arch. Entwicklungsmech. Organ.
Archiv fuer Entwicklungsmechanik der Organismen, Wilhelm Roux' *(West Germany)*
Arch. Environ. Health
*Archives of Environmental Health (formerly A.M.A. Archives of Industrial Health) *(U. S.)*
Arch. Exp. Pathol. Pharmakol.
Archiv fuer Experimentelle Pathologie und Pharmakologie, Naunyn-Schmiedebergs *(Germany)*
Arch. Exp. Veterinaermed.
Archiv fuer Experimentelle Veterinaermedizin *(Germany)*
Arch. Fr. Pediat.
*Archives Francaises de Pediatrie *(France)*
Arch. Geschwulstforsch.
*Archiv fuer Geschwulstforschung *(East Germany)*
Arch. Ges. Physiol.
*Archiv fuer die Gesamte Physiologie des Menschen und der Tiere, Pfluegers *(Germany)*
Arch. Ges. Virusforsch.
*Archiv fuer die Gesamte Virusforschung *(Austria)*
Arch. Gorn.
Archiwum Gornictwa *(Poland)*
Arch. Gynaekol.
*Archiv fuer Gynaekologie *(West Germany)*
Arch. Hosp. Univ. (Havana)
Archivos de Hospitales Universitarios (Havana) (formerly Archivos del Hospital Universitario) *(Cuba)*
Arch. Hosp. Vargas (Caracas)
Archivos del Hospital Vargas (Caracas) *(Venezuela)*
Arch. Hutn.
Archiwum Hutnictwa *(Poland)*
Arch. Hyg. Bakteriol.
*Archiv fuer Hygiene und Bakteriologie *(Germany)*
Arch. Immunol. Ter. Dosw.
Archiwum Immunologii i Terapii Doswaidczalnej
see Arch. Immunol. Ther. Exp.
Arch. Immunol. Ther. Exp.
*Archivum Immunologiae et Therapiae Experimentalis *(Poland)*
Arch. Interamer. Rheumatol.
*Archives of Interamerican Rheumatology *(Brazil)*
Arch. Intern. Med.
*Archives of Internal Medicine (formerly A.M.A. Archives of Internal Medicine) *(U. S.)*
Arch. Int. Pharmacodyn.
*Archives Internationales de Pharmacodynamie et de Therapie *(Belgium)*
Arch. Int. Physiol. Biochim.
*Archives Internationales de Physiologie et de Biochimie *(Belgium)*
Arch. Ital. Biol.
*Archives Italiennes de Biologie *(Italy)*
Arch. Klin. Chir.
*Archiv fuer Klinische Chirurgie, Langenbecks *(Germany)*
Arch. Klin. Exp. Dermatol.
*Archiv fuer Klinische und Experimentelle Dermatologie *(West Germany)*
Arch. Kreislaufforsch.
*Archiv fuer Kreislaufforschung *(West Germany)*
Arch. Landtech.
Archiv fuer Landtechnik *(East Germany)*
Arch. Lebensmittelhyg.
Archiv fuer Lebensmittelhygiene Insbesondere fuer Fleisch, Fisch, und Milchhygiene *(West Germany)*
Arch. Mat. Naturvidensk.
*Archiv for Matematik og Naturvidenskab *(Norway)*
Arch. Med. Mex.
Archivos Medicos Mexicanos *(Mexico)*
Arch. Meteorol. Geophys. Bioklimatol., Ser. A
Archiv fuer Meteorologie, Geophysik und Bioklimatologie, Series A *(Austria)*
Arch. Mikrobiol.
*Archiv fuer Mikrobiologie *(Germany)*
Arch. Neurol.
*Archives of Neurology *(U.S.)*
Arch. Ohren, Nasen- Kehlkopfheilk.
Archiv fuer Ohren-, Nasen- und Kehlkopfheilkunde, Vereinigt mit Zeitschrift fuer Hals-, Nasen- und Ohrenheilkunde *(Germany)*
Arch. Ophthalmol. (Berlin)
*Archiv fuer Ophthalmologie Vereinigt mit Archiv fuer Augenheilkunde, Albrecht von Graefes (Berlin) *(Germany)*
Arch. Ophthalmol. (Chicago)
Archives of Ophthalmology (Chicago) *(U. S.)*
Arch. Oral Biol.
*Archives of Oral Biology *(U. S.—England)*
Arch. Orthopaed. Unfallchir.
Archiv fuer Orthopaedische und Unfallchirurgie *(Germany)*
Arch. Ortop.
Archivio di Ortopedia *(Italy)*
Arch. Otolaryngol.
*Archives of Otolaryngology *(U. S.)*
Arch. Pathol.
*Archives of Pathology (formerly A.M.A. Archives of Pathology) *(U. S.)*
Arch. Pathol. Anat.
*Archiv fuer Pathologische Anatomie und Physiologie fuer Klinische Medizin, Virchows *(Germany)*
Arch. Patol. Clin. Med.
Archivio di Patologia e Clinica Medica *(Italy)*
Arch. Peru. Patol. Clin. (Lima)
Archivos Peruanos de Pathologia y Clinica (Lima) *(Peru)*
Arch. Pharm.
*Archiv der Pharmazie und Berichte der Deutschen Pharmazeutischen Gesellschaft (includes Mitteilungen der Deutschen Pharmazeutischen Gesellschaft und der Pharmazeutischen Gesellschaft der DDR) *(East Germany)*
Arch. Pharmakol. Exp. Pathol.
*Archiv fuer Pharmakologie und Experimentelle Pathologie (formerly Archiv fuer Experimentelle Pathologie und Pharmakologie, Naunyn-Schmiedebergs) *(West Germany)*
Arch. Psychiat. Nervenkrankh.
Archiv fuer Psychiatrie und Nervenkrankheiten Vereinigt mit Zeitschrift fuer die Gesamte Neurologie und Psychiatrie *(Germany)*
Arch. "Putti" Chir. Organi Movimento
Archivio "Putti" di Chirurgia degli Organi di Movimento *(Italy)*

Arch. Ration. Mech. Anal.
Archive for Rational Mechanics and Analysis *(West Germany)*
Arch. Roum. Pathol. Exp. Microbiol.
Archives Roumaines de Pathologie Experimentale et de Microbiologie *(France)*
Arch. Sci. Med.
Archivio per le Scienze Mediche *(Italy)*
Arch. Sci. Physiol.
*Archives des Sciences Physiologiques *(France)*
Arch. Soc. Estud. Clin. Habana
Archivos de la Sociedad de Estudios Clinicos de la Habana *(Cuba)*
Arch. Surg.
*Archives of Surgery *(U.S.)*
Arch. Tech. Messen
*Archiv fuer Technisches Messen und Industrielle Messtechnik *(Germany)*
Arch. Venezol. Patol. Trop. Parisitol. Med.
Archivos Venezolanos de Patologia Tropical y Parasitologia Medica *(Venezuela)*
Arch. Vet. Ital.
Archivio Veterinario Italiano *(Italy)*
Argonne Nat. Lab. Rev.
*Argonne National Laboratory Reviews (supersedes News-Bulletin International (Argonne National Laboratory)) *(U. S.)*
Ark. Biol. Nauka (Belgrade)
Arhiv Bioloskih Nauka (Belgrade)† *(Yugoslavia)*
Ark. Farm. (Belgrade)
Arhiv za Farmaciju (Belgrade) *(Yugoslavia)*
Ark. Hig. Rada Toksikol.
Arhiv za Higijenu Rada i Toksikologiju (formerly Arhiv za Higijenu Rada) *(Yugoslavia)*
Ark. Poljopr. Nauke
Arhiv za Poljoprivredne Nauke *(Yugoslavia)*
Ark. Astron.
*Arkiv for Astronomi, Utgivet av Kungl. Svenska Vetenskop-sakademien *(Sweden)*
Ark. Fys.
*Arkiv for Fysik *(Sweden)*
Ark. Fys. Seminar Trondheim
*Arkiv for det Fysiske Seminar i Trodheim *(Norway)*
Ark. Geofys.
*Arkiv for Geofysik, Utgivet av Kungl. Svenska Vetenskapsakademien *(Sweden)*
Arkh. Patol.
*Arkhiv Patologii *(U. S. S. R.)*
Ark. Kemi
*Arkiv for Kemi, Utgivet av Kungl. Svenska Vetenskapsakademien *(Sweden)*
Ark. Mineral. Geol.
*Arkiv for Mineralogi och Geologi, Utgivet av Kungl. Vetenskapsakademien *(Sweden)*
Arm. Khim. Zh.
*Armyanskii Khimicheskii Zhurnal (Formerly Izvestiya Akademii Nauk Armyanskoi SSR, Khimicheskie Nauk) *(Armenian S.S.R.)*
Arq. Brasil. Cardiol.
Arquivos Brasileiros de Cardiologia *(Brazil)*
Arq. I.B.I.T. (Inst. Brasil. Invest. Tuberc.)
Arquivos do I.B.I.T. (Instituto Brasileiro para Investigacao da Tuberculose) *(Brazil)*
Arq. Mineir. Leprol.
Arquivos Mineiros de Leprologia *(Brazil)*
Arq. Patol. (Lisbon)
Arquivos de Patologia (Lisbon) *(Portugal)*
Arq. Tisiol.
Arquivos de Tisiologia *(Portugal)*
Arthritis Rheum.
*Arthritis and Rheumatism *(U. S.)*
Arzneim.-Forsch.
*Arzneimittel-Forschung *(Germany)*
Asahi Garasu Kenkyu Hokoku
*Asahi Garasu Kenkyu Hokoku (Reports of the Research Lab., Asahi Glass Co.) *(Japan)*
ASB (Ass. Southeastern Biol.) Bull.
ASB (Association of Southeastern Biologists) Bulletin *(U. S.)*
ASHRAE (Amer. Soc. Heat., Refrig. Air-Cond. Eng.) J.
ASHRAE (American Society of Heating, Refrigeration and Air-conditioning Engineers) Journal *(U. S.)*
ASLE (Amer. Soc. Lubric. Eng.) Trans.
*ASLE (American Society of Lubrication Engineers) Transactions *(U. S.)*

Astronaut. Acta
*Astronautica Acta *(Austria)*
Astronaut. Aeronaut.
*Astronautics & Aeronautics (formerly Astronautics and Aerospace Engineering) *(U. S.)*
Astronautyka
Astronautyka *(Poland)*
Astron. J.
*Astronomical Journal, The *(U.S.)*
Astron. Nachr.
Astronomische Nachrichten *(Germany)*
Astron. Soc. Jap., Publ.
Astronomical Society of Japan, Publications *(Japan)*
Astron. Zh.
*Astronomicheskii Zhurnal *(U.S.S.R.)*
Astrophys. J.
*Astrophysical Journal, The *(U. S.)*
Astrophys. J., Suppl. Ser.
*Astrophysical Journal, The, Supplement Series *(U. S.)*
Astrophys. Norv.
*Astrophysica Norvegica *(Norway)*
Ateneo Parmense
Ateneo Parmense, L' *(Italy)*
At. Energ. (USSR)
*Atomnaya Energiya† *(U.S.S.R.)*
At. Energy Aust.
*Atomic Energy in Australia *(Australia)*
At. Energy Rev.
*Atomic Energy Review *(Austria)*
Atom
*Atom *(England)*
Atomkernenergie
*Atomkernenergie (formerly Atomenergie) *(Germany)*
ATOMKI (At. Kut. Intez.) Kozlem.
*ATOMKI (Atommag Kutato Intezet) Kozlemenyek (formerly carried under the title: Magyar Tudomanyos Akademia Atommag Kutato Intezete (Debrecen). Kozlemenyek) *(Hungary)*
Atomlight
*Atomlight *(U. S.)*
Atomo, Petrol., Elet.
Atomo, Petrolio, Elettricita *(Italy)*
Atompraxis
*Atompraxis *(Germany)*
Atomtech. Tajek.
*Atomtechnikai Tajekoztato *(Hungary)*
Atomwirt., Atomtech.
*Atomwirtschaft, Atomtechnik (formerly Atomwirtschaft, Die) *(West Germany)*
Atomwirtschaft
Atomwirstschaft, Die *(Germany)*
Atoomenergie Haar Toepass.
*Atoomenergie en Haar Toepassingen (formerly RCN Bulletin) *(Netherlands)*
At. Strom
*Atom und Strom *(Germany)*
Atti Accad. Naz. Ital. Entomol., Rend.
Atti della Accademia Nazionale Italiana di Entomologia, Rendiconti *(Italy)*
Atti Accad. Naz. Lincei, Rend., Cl. Sci. Fis., Mat. Natur.
*Atti della Accademia Nazionale dei Lincei. Rendiconti, Classe di Scienze Fisiche, Matematiche e Naturali *(Italy)*
Atti Accad. Sci. Torino: I. Cl. Sci. Fis., Mat. Natur.
*Atti della Accademia delle Scienze di Torino. Part I. Classe Scienze Fisiche, Matematiche e Naturali *(Italy)*
Atti Ass. Genet. Ital.
*Atti Associazone Genetica Italiana *(Italy)*
Atti Notiz., Ass. Ital. Met.
Atti i Notizie, Associazione Italiana di Metallurgia *(Italy)*
Atti Seminar. Mat. Fis. Univ. Modena
*Atti del Seminario Matematico e Fisico dell'Universita di Modena *(Italy)*
Atti Soc. Ital. Sci. Vet.
Atti della Societa Italiana di Scienze Veterinarie *(Italy)*
Atti Soc. Natur. Mat. Modena
*Atti della Societa dei Naturalisti e Matematici di Modena *(Italy)*
Atti Soc. Peloritana Sci. Fis. Mat. Natur.
Atti della Societa Peloritana di Scienze Fisiche Matematiche e Naturali *(Italy)*
Attual. Obtet. Ginecol.
Attualita di Ostetrica e Ginecologia *(Italy)*
Audio

*Audio; Engineering, Music, Sound Reproduction *(U.S.)*
Auk
Auk *(U. S.)*
Aust. Dent. J.
Australian Dental Journal *(Australia)*
Aust. J. Agr. Res.
*Australian Journal of Agricultural Research *(Australia)*
Aust. J. Appl. Sci.
*Australian Journal of Applied Science *(Australia)*
Aust. J. Biol. Sci.
*Australian Journal of Biological Sciences *(Australia)*
Aust. J. Chem.
*Australian Journal of Chemistry *(Australia)*
Aust. J. Exp. Biol. Med. Sci.
Australian Journal of Experimental Biology and Medical Science, The *(Australia)*
Aust. J. Instrum. Technol.
*Australian Journal of Instrument Technology *(Australia)*
Aust. J. Phys.
*Australian Journal of Physics *(Australia)*
Aust. J. Phys., Astrophys. Suppl.
*Australian Journal of Physics, Astrophysical Supplement *(Australia)*
Aust. J. Sci.
*Australian Journal of Science, The *(Australia)*
Aust. N. Z. J. Obstet. Gynaecol.
Australian and New Zealand Journal of Obstetrics and Gynaecology *(Australia)*
Aust. N. Z. J. Surg.
Australian and New Zealand Journal of Surgery *(Australia)*
Aust. Phys.
*Australian Physicist *(Australia)*
Australas. Ann. Med.
*Australasian Annals of Medicine *(Australia)*
Australas. Inst. Mining Met. Proc.
Australasian Institute of Mining and Metallurgy Proceedings *(Australia)*
Australas. J. Pharm.
Australasian Journal of Pharmacy *(Australia)*
Australas. Radiol.
*Australasian Radiology (formerly Journal of the College of Radiologists of Australasia) *(Australia)*
Automat. Contr.
Automatic Control
Automation
Automation
see Otomeshon
see Jido Seigyo
Automatisme
Automatisme *(France)*
Automat. Remote Contr. (Engl. Transl.)
*Automation and Remote Control (English Translation of Avtomatika i Telemekhanika) *(U.S.)*
Automat. Weld. (USSR) (Engl. Transl.)
Automatic Welding (USSR) (English Translation of Avtomaticheskaya Svarka) *(U. S.)*
Automaz. Automat.
Automazione e Automatismi *(Italy)*
Avian Dis.
*Avian Diseases *(U.S.)*
Aviat. Kosmonavt.
Aviatsiya i Kosmonavtika *(U.S.S.R.)*
Avtomat. Svarka
Avtomaticheskaya Svarka† *(Ukrainian S.S.R.)*
Avtomat. Telemekh.
Avtomatika i Telemekhanika *(U.S.S.R.)*
Azerb. Khim. Zh.
*Azerbaidzhanskii Khimicheskii Zhurnal *(Azerbaidzhan S.S.R.)*
Bacteriol. Rev.
*Bacteriological Reviews *(U.S.)*
Baender, Bleche, Rohre
Baender, Bleche, Rohre *(West Germany)*
Banyasz. Kut. Intez. Kozlem.
Banyaszati Kutato Intezet Kozlemenyei *(Hungary)*
Battelle Tech. Rev.
*Battelle Technical Review *(U. S.)*
Bauingenieur
Bauingenieur *(Germany)*
Bayer. Landwirt. Jahrb.
*Bayerisches Landwirtschaftliches Jahrbuch *(West Germany)*
Beitr. Geophys.
*Beitraege zur Geophysik, Gerlands *(Germany)*

Beitr. Pathol. Anat. Allg. Pathol.
Beitraege zur Pathologischen Anatomie und zur Allgemeinen Pathologie *(Germany)*
Beitr. Plasmaphys.
*Beitraege aus der Plasmaphysik *(Germany)*
Belgicatom, Ass. Belge Develop. Pac. Energ. At., Bull. Inform.
Belgicatom, Association Belge pour le Developpment Pacifique de l'Energie Atomique, Bulletin d'Information *(Belgium)*
Bell Lab. Rec.
*Bell Laboratories Record *(U.S.)*
Bell Syst. Tech. J.
*Bell System Technical Journal *(U.S.)*
Bell Telephone Syst., Tech. Publ., Monogr.
Bell Telephone System, Technical Publications, Monographs *(U. S.)*
Ber. Bunsenges. Physik. Chem.
*Berichte der Bunsengesellschaft fuer Physikalische Chemie (formerly Zeitschrift fuer Elektrochemie) *(Germany)*
Ber. Deut. Bot. Ges.
Berichte der Deutschen Botanischen Gesellschaft *(Germany)*
Ber. Deut. Keram. Ges.
*Berichte der Deutschen Keramischen Gesellschaft e. V. *(Germany)*
Ber., Deut. Ophthalmol. Ges.
Berichte der Deutschen Ophthalmologischen Gesellschaft *(Germany)*
Berg- Huettenmaennische Monatsh.
Berg- und Huettenmaennische Monatshefte *(Austria)*
Ber. Phys.-Med. Ges. Wuerzburg
Berichte der Physikalisch-Medizinischen Gesellschaft zu Wuerzburg *(West Germany)*
Berufsdermatosen
*Berufsdermatosen: Occupational Dermatoses *(Germany)*
Betonstein Ztg.
Betonstein Zeitung *(West Germany)*
Bibl. Anat.
*Bibliotheca Anatomica *(Switzerland)*
Bibl. Cardiol.
*Bibliotheca Cardiologica, Supplementa ad Cardiologia *(Switzerland)*
Bibl. Gastroenterol.
*Bibliotheca Gastroenterologica, Supplementum ad Gastroenterologica *(Switzerland)*
Bibl. Gynaecol.
*Bibliotheca Gynaecologica, Supplementum ad Gynaecologica *(Switzerland)*
Bibl. Haematol.
*Bibliotheca Haematologica, Supplementa ad Acta Haematologica *(Switzerland)*
Bibl. Microbiol.
*Bibliotheca Microbiologica, Supplementum ad Pathologia et Microbiologia *(Switzerland)*
Bibl. Nutr. Dieta
*Bibliotheca Nutritio et Dieta, Supplementa ad Nutritio ed Dieta *(Switzerland)*
Bibl. Ophthalmol.
*Bibliotheca Ophthalmologica, Supplementa ad Ophthalmologica *(Switzerland)*
Bibl. Oto-Rhino-Laryngol.
*Bibliotheca Oto-Rhino-Laryngologica, Supplementa ad Practica-Oto-Rhino-Laryngologica *(Switzerland)*
Bibl. Paediat.
*Bibliotheca Paediatrica, Supplementa ad Annales Paediatrica *(Switzerland)*
Bibl. Phonetica
Bibliotheca Phonetica *(Switzerland)*
Bibl. Primatol.
*Bibliotheca Primatologica *(Switzerland)*
Bibl. Psychiat. Neurol.
Bibliotheca Psychiatrica et Neurologica, Supplementa ad Psychiatria et Neurologica *(Switzerland)*
Bibl. Radiol.
*Bibliotheca Radiologica, Supplementa ad Radiologia Clinica *(Switzerland)*
Bibl. Tuberc.
*Bibliotheca Tuberculosea, Supplementa ad Schweizerische Zeitschrift fuer Tuberkulose und Pneumonologie *(Switzerland)*
Bibl. "Vita Humana"
*Bibliotheca "Vita Humana" *(Switzerland)*
Biken J.
*Biken Journal (Journal of the Research Institute for Microbial

Diseases) *(Japan)*

Bild. Wiss.
Bild der Wissenschaft *(West Germany)*

Biochem. Biophys. Res. Commun.
*Biochemical and Biophysical Research Communications *(U. S.)*

Biochem. Clin.
Biochemical Clinics *(U. S.)*

Biochemistry
*Biochemistry *(U. S.)*

Biochemistry (USSR) (Engl. Transl.)
*Biochemistry (USSR) (English Translation of Biokhimiya) *(U. S.)*

Biochem. J.
*Biochemical Journal *(England)*

Biochem. Pharmacol.
*Biochemical Pharmacology *(England)*

Biochem. Z.
Biochemische Zeitschrift *(Germany)*

Biochim. Biophys. Acta
*Biochimica et Biophysica Acta *(U. S.)*

Biol. Bull.
*Biological Bulletin, The *(U. S.)*

Biol. Deistvie Radiats., L'vov. Gos. Univ.
Biologicheskoe Deistvie Radiatsii, L'vovskii Gosudarstvennyi Universitet im. Iv. Franka *(Ukrainian S.S.R.)*

Biol. Glas.
Bioloski Glasnik *(Yugoslavia)*

Biol. Kozlem.
Biologiai Kozlemenyek *(Hungary)*

Biol. Med. (Paris)
*Biologie Medicale (Paris) *(France)*

Biol. Neonatorum
*Biologia Neonatorum *(Switzerland)*

Biologia (Bratislava)
Biologia (Bratislava) *(Czechoslovakia)*

Biol. Plant., Acad. Sci. Bohemoslov.
*Biologia Plantarum, Academia Scientiarum Bohemoslovenica *(Czechoslovakia)*

Biol. Rev. Cambridge Phil. Soc.
*Biological Reviews of the Cambridge Philosophical Society *(England)*

Biol. Zentralbl.
Biologisches Zentralblatt *(East Germany)*

Biol. Zh. Arm.
*Biologicheskii Zhurnal Armenii (Formerly Izvestiya Akademii Nauk Armyanskoi SSR, Biologicheskie Nauki) *(Armenian S.S.R.)*

Bio-Med. Eng.
Bio-Medical Engineering *(England)*

Biometrics
*Biometrics *(U.S.)*

Biometrika
*Biometrika *(England)*

Biophysics (USSR) (Engl. Transl.)
*Biophysics (USSR) (English Translation of Biofizika) *(England)*

Biophysik
*Biophysik *(Germany)*

Biophys. J.
*Biophysical Journal *(U. S.)*

Biophys. J., Suppl.
*Biophysical Journal, Supplement *(U. S.)*

Biopolymers
*Biopolymers (supersedes in part the Journal of Polymer Science) *(U. S.)*

Bios (Mount Vernon, Iowa)
Bios (Mount Vernon, Iowa) *(U. S.)*

Biotechnol. Bioeng.
*Biotechnology and Bioengineering *(England)*

Birth Defects, Orig. Article Ser.
Birth Defects, Original Article Series *(U. S.)*

Bitamin
Bitamin (Vitamins (Kyoto)) *(Japan)*

Blast Furnace Steel Plant
Blast Furnace and Steel Plant *(U. S.)*

Blood
*Blood. The Journal of Hematology *(U. S.)*

Blut
*Blut *(Germany)*

Boei Eisei
*Boei Eisei (National Defense Medical Journal) *(Japan)*

Boira Kenkyu
*Boira Kenkyu (Journal of the Japan Boiler Association) *(Japan)*

Bol. Asoc. Med. Puerto Rico
Boletin de la Asociacion Medica de Puerto Rico *(Puerto Rico)*

Bol. Chil. Parasitol.
Boletin Chileno de Parasitologia *(Chile)*

Bol. Fac. Ing. Agri-Mens. Montevideo
Boletin de la Facultad de Ingenieria y Agri-Mensura de Montevideo *(Uruguay)*

Bol. Hosp. Oftalmol. Nuestra Senora de la Luz
Boletin del Hospital Oftalmologico de Nuestra Senora de la Luz *(Mexico)*

Bol. Inst. Estud. Med. Biol. (Mex.)
Boletin del Instituto de Estudios Medicos y Biologicos *(Mexico)*

Bol. Inst. Mat. Astron. Fis.
Boletin del Instituto de Matematica Astronomia y Fisica *(Argentina)*

Bol. Junta Contr. Energ. At. (Peru)
*Boletin de la Junta do Control de Energia Atomica (formerly Boletin de Informaciones de la Junta do Control de Energia Atomica) *(Peru)*

Boll. Ist. Sieroter. Milan.
Bollettino dell'Istituto Sieroterapico Milanese *(Italy)*

Boll. Sci. Fac. Chim. Ind. Bologna
Bollettino Scientifico della Facolta di Chimica Industriale di Bologna *(Italy)*

Boll. Soc. Ital. Biol. Sper.
*Bollettino della Societa Italiana di Biologia Sperimentale *(Italy)*

Bol. Serv. Plagas Forest.
Boletin del Servicio de Plagas Forestales *(Spain)*

Bol. Soc. Cubana Dermatol. Sifiliog.
Boletin de la Sociedad Cubana de Dermatologia y Sifiliografia *(Cuba)*

Bol. Soc. Med. Centro Materno "Gral. Maximino Avila Camacho"
Boletin de la Sociedad Medica del Centro Maternao "Gral. Maximino Avila Camacho" *(Mexico)*

Bol. Trab. Soc. Cir. Buenos Aires
Boletines y Trabajos; Sociedad de Cirugia de Buenos Aires *(Argentina)*

Bol. Univ. Parana, Fis. Teorica
*Boletim da Universidade do Parana, Fisica Teorica *(Brazil)*

Bordeaux Chir.
Bordeaux Chirurgicale *(France)*

Boshoku Gijutsu
*Boshoku Gijutsu (Corrosion Engineering) *(Japan)*

Bot. Bull. Acad. Sinica (Taiwan)
*Botanical Bulletin of Academia Sinica (Taiwan) *(China)*

Bot. Gaz.
*Botanical Gazette, The *(U. S.)*

Brain
*Brain, A Journal of Neurology *(England)*

Brain Nerve (Tokyo)
Brain and Nerve *(Tokyo)*
see No To Shinkei

Bratisl. Lek. Listy
Bratislavske Lekarske Listy *(Czechoslovakia)*

Brauwissenschaft
Brauwissenschaft *(Germany)*

Brennstoff-Chem.
*Brennstoff-Chemie *(Germany)*

Brennstoff-Waerme-Kraft
*Brennstoff-Waerme-Kraft *(Germany)*

Brigham Young Univ. Sci. Bull., Biol. Ser.
*Brigham Young University Science Bulletin, Biological Series *(U. S.)*

Bristol Med.-Chir. J.
Bristol Medico-Chirurgical Journal *(England)*

Brit. Chem. Eng.
*British Chemical Engineering *(England)*

Brit. Columbia Med. J.
British Columbia Medical Journal *(Canada)*

Brit. Commun. Electron.
British Communications and Electronics *(England)*

Brit. Corros. J.
British Corrosion Journal *(England)*

Brit. Dent. J.
British Dental Journal *(England)*

Brit. Heart J.
*British Heart Journal *(England)*

Brit. J. Anaesth.
*British Journal of Anaesthesia *(England)*

Brit. J. Appl. Phys.
*British Journal of Applied Physics *(England)*
Brit. J. Cancer
*British Journal of Cancer *(England)*
Brit. J. Clin. Pract.
British Journal of Clinical Practice, incorporating Medicine Illustrated *(England)*
Brit. J. Dermatol.
*British Journal of Dermatology *(England)*
Brit. J. Exp. Pathol.
*British Journal of Experimental Pathology, The *(England)*
Brit. J. Haematol.
*British Journal of Haematology *(England)*
Brit. J. Ind. Med.
*British Journal of Industrial Medicine *(England)*
Brit. J. Med .Psychol.
*British Journal of Medical Psychology *(England)*
Brit. J. Non-Destruct. Test.
*British Journal of Non-Destructive Testing *(England)*
Brit. J. Nutr.
*British Journal of Nutrition, The *(England)*
Brit. J. Ophthalmol.
*British Journal of Ophthalmology *(England)*
Brit. J. Pharmacol.
*British Journal of Pharmacology and Chemotherapy *(England)*
Brit. J. Prev. Soc. Med.
*British Journal of Preventive & Social Medicine *(England)*
Brit. J. Psychol.
British Journal of Psychology *(England)*
Brit. J. Radiol.
*British Journal of Radiology *(England)*
Brit. J. Surg.
*British Journal of Surgery, The *(England)*
Brit. J. Urol.
British Journal of Urology, The *(Scotland)*
Brit. J. Vener. Dis.
*British Journal of Venereal Diseases, The *(England)*
Brit. Med. Bull.
*British Medical Bulletin *(England)*
Brit. Med. J.
British Medical Journal, The *(England)*
Brit. Mycol. Soc. Trans.
*British Mycological Society Transactions, The *(England)*
Brit. Poultry Sci.
British Poultry Science *(Scotland)*
Brit. Vet. J.
*British Veterinary Journal, The *(England)*
Brit. Weld. J.
*British Welding Journal *(England)*
Brown Boveri Rev.
Brown Boveri Review *(Switzerland)*
Bul. Inst. Politeh. Bucuresti
*Buletinul Institutului Politehnic Bucuresti *(Romania)*
Bul. Inst. Politeh. Iasi
Buletinul Institutului Politehnic din Iasi *(Romania)*
Bull. Acad. Nat. Med. (Paris)
Bulletin de l'Academie Nationale de Medecine (Paris) *(France)*
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*Bulletin de l'Academie Polonaise des Sciences, Serie des Sciences Biologiques *(Poland)*
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*Bulletin de l'Academie Polonaise des Sciences, Serie des Sciences Techniques *(Poland)*
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Bulletin de l'Academie Royale de Medecine de Belgique *(Belgium)*
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Bulletin de l'Academie Veterinaire de France *(France)*
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*Bulletin of the American Mathematical Society *(U.S.)*
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*Bulletin of the American Meteorological Society *(U.S.)*
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Bulletin de l'Association Francaise pour l' Etude du Cancer *(France)*
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*Bulletin of the Astronomical Institutes of Czechoslovakia *(Czechoslovakia)*
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Bulletin of the Atmospheric Radioactivity (Japan) **see *Taiki Hoshano Kansoku Seiseki***
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Bulletin Biologique de la France et de la Belgique *(France)*
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*Bulletin of the Boris Kidrich Institute of Nuclear Sciences *(Yugoslavia)*
Bull. Cancer
*Bulletin du Cancer (formerly Bulletin de l'Association Francaise pour l'Etude du Cancer) *(France)*
Bull. Chem. Soc. Jap.
*Bulletin of the Chemical Society of Japan *(Japan)*
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*Bulletin de la Classe des Sciences, Academie Royale de Belgique *(Belgium)*
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Bulletin of the Electrotechnical Laboratory (Tokyo) **see *Denki Shikensho Iho***
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*Bulletin of the Georgia Academy of Science *(U. S.)*
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Bulletin of the Heart Institute, Japan *(Japan)*
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Bulletin of the Hospital for Joint Diseases *(U. S.)*
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*Bulletin d'Information sur les Applications Industrielles des Radioelements. Supplement au Bulletin d'Information de l'A.T.E.N. (Association Technique pour l'Energie Nucleaire) *(France)*
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*Bulletin d'Information de l'Association Belge pour le Developpement Pacifique de l'Energie Atomique *(Belgium)*
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*Bulletin d'Information A.T.E.N. (Association Technique pour l'Energie Nucleaire) *(France)*
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*Bulletin of the Institute of Chemistry, Academia Sinica *(China)*
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*Bulletin de l'Institut Oceanographique *(Monaco)*
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Bulletin, Mount Desert Island Biological Laboratory *(U. S.)*

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Bulletin of National Institute of Animal Health
see Kochiku Eisei Shikenjo Kenkyu Hokoku

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see Eisei Shikensho Hokoku

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*Bulletin of the New York Academy of Medicine *(U. S.)*

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Bulletin of Pathology (Chicago) *(U. S.)*

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Bulletin of Polish Medical Science and History *(U. S.)*

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Bulletin on Rheumatic Diseases *(U. S.)*

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*Bulletin der Schweizerischen Akademie der Medizinischen Wissenschaften *(Switzerland)*

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Bulletin des Schweizerischen Elektrotechnischen Vereins *(Switzerland)*

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see Waseda Daigaku Rikagaku Kenkyusho Hokoku

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*Bulletin of the Seismological Society of America *(U. S.)*

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Bulletin of the Shimane University, Natural Science
see Shimane Daigaku Ronshu

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*Bulletin de la Societe des Amis des Sciences et des Lettres de Poznan, Serie B *(Poland)*

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Bulletin de la Societe Belge de Geologie, de Paleontologie et d'Hydrologie *(Belgium)*

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Bulletin de la Societe Belge d'Ophtalmologie *(Belgium)*

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*Bulletin des Societes Chimiques Belges *(Belgium)*

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*Bulletin de la Societe de Chimie Biologique *(France)*

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*Bulletin de la Societe Chimique de France *(France)*

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*Bulletin de la Societe Francaise de Ceramique *(France)*

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Bulletin de la Societe Francaise de Dermatologie et de Syphiliographie *(France)*

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*Bulletin de la Societe Francaise de Mineralogie et de Cristallographie *(France)*

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Bulletin de la Societe Internationale de Chirurgie *(Belgium)*

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*Bulletin de la Societe Mathematique de France *(France)*

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Bulletin de la Societe Royale Belge de Gynecologie et d'Obstetrique *(Belgium)*

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*Bulletin de la Societe Royale des Sciences de Liege *(Belgium)*

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Bulletin de la Societe Scientifique de Bretagne *(France)*

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Bulletin de la Societe des Sciences Medicales du Grand-Duche de Luxembourg *(Luxembourg)*

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Bulletin Technique de la Societe Francaise des Constructions Babcock et Wilcox *(France)*

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Bulletin of the Tokyo Institute of Technology *(Japan)*

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Bulletin of Tokyo Medical and Dental University *(Japan)*

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Bulletin of the Torrey Botanical Club *(U. S.)*

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Bulletin of the University of Osaka Prefecture, Series A *(Japan)*

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Bulletin of the Utah Engineering Experiment Station *(U. S.)*

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*Bulletin of the World Health Organization *(U.S.)*

Bul. Stiint. Inst. Politeh. Cluj
*Buletinul Stiintific al Institutului Politehnic din Cluj *(Romania)*

Bunko Kenkyu
*Bunko Kenkyu (Journal of the Spectroscopical Society of Japan) *(Japan)*

Bunseki Kagaku
*Bunseki Kagaku (Japan Analyst) *(Japan)*

Burma Med. J.
Burma Medical Journal *(Burma)*

Bussei
*Bussei (Solid State Physics and Chemistry) *(Japan)*

Butsuri Tanko
Butsuri Tanko (Geophysical Exploration) *(Japan)*

Byull. Eksp. Biol. Med.
*Byulleten Eksperimental'noi Biologii i Meditsiny† *(U.S.S.R.)*

Cah. Coll. Med.
Cahiers du College de Medecine des Hopitaux de Paris *(France)*

Cah. Phys.
*Cahiers de Physique *(France)*

Calif. Med.
*California Medicine *(U. S.)*

Calore
Calore, Il *(Italy)*

CA, Med. J.
CA, A Medical Journal Published by the American Cancer Society *(U. S.)*

Can. Aeronaut. Space J.
*Canadian Aeronautics and Space Journal *(Canada)*

Can. Cancer Conf.
Canadian Cancer Conference *(Canada)*

Cancer
*Cancer *(U. S.)*

Cancer Chemother. Rep.
Cancer Chemotherapy Reports *(U. S.)*

Cancer Progr.
Cancer Progress *(England)*

Cancer Res.
*Cancer Research *(U. S.)*

Cancer Seminar
Cancer Seminar *(U. S.)*

Can. Chem. Process.
*Canadian Chemical Processing *(Canada)*

Can. Contr. Instrum.
*Canadian Controls and Instrumentation *(Canada)*

Concro
Concro, Il *(Italy)*

Can. Entomol.
*Canadian Entomologist, The *(Canada)*

Can. Geophys. Bull.
*Canadian Geophysical Bulletin *(Canada)*

Can. J. Anim. Sci.
*Canadian Journal of Animal Science *(Canada)*

Can. J. Biochem.
*Canadian Journal of Biochemistry (supersedes in part Canadian Journal of Biochemistry and Physiology) *(Canada)*

Can. J. Bot.
*Canadian Journal of Botany *(Canada)*

Can. J. Chem.
*Canadian Journal of Chemistry *(Canada)*

Can. J. Chem. Eng.
*Canadian Journal of Chemical Engineering (formerly Canadian Journal of Technology) *(Canada)*

Can. J. Comp. Med. Vet. Sci.
*Canadian Journal of Comparative Medicine and Veterinary Science *(Canada)*

Can. J. Earth Sci.
*Canadian Journal of Earth Sciences *(Canada)*

Can. J. Genet. Cytol.
*Canadian Journal of Genetics and Cytology *(Canada)*
Can. J. Math.
*Canadian Journal of Mathematics *(Canada)*
Can. J. Med. Technol.
*Canadian Journal of Medical Technology, The *(Canada)*
Can. J. Microbiol.
*Canadian Journal of Microbiology *(Canada)*
Can. J. Phys.
*Canadian Journal of Physics *(Canada)*
Can. J. Physiol. Pharmacol.
*Canadian Journal of Physiology and Pharmacology (supersedes in part Canadian Journal of Biochemistry and Physiology) *(Canada)*
Can. J. Plant Sci.
*Canadian Journal of Plant Science *(Canada)*
Can. J. Public Health
*Canadian Journal of Public Health *(Canada)*
Can. J. Zool.
*Canadian Journal of Zoology *(Canada)*
Can. Math. Bull.
*Canadian Mathematical Bulletin *(Canada)*
Can. Med. Ass. J.
*Canadian Medical Association Journal, The *(Canada)*
Can. Met. Quart.
*Canadian Metallurgical Quarterly *(Canada)*
Can. Mineral.
Canadian Mineralogist, The *(Canada)*
Can. Mining J.
*Canadian Mining Journal *(Canada)*
Can. Mining Met. Bull.
*Canadian Mining and Metallurgical Bulletin, The *(Canada)*
Can. Nucl. Technol.
*Canadian Nuclear Technology *(Canada)*
Can. Pat. Office Rec.
*Canadian Patent Office Record *(Canada)*
Can. Power Eng.
*Canadian Power Engineer *(Canada)*
Can. Serv. Med. J.
*Canadian Services Medical Journal *(Canada)*
Can. Spectrosc.
*Canadian Spectroscopy *(Canada)*
Can. Weld. Fabr.
*Canadian Welder & Fabricator *(Canada)*
Carbon
*Carbon *(England)*
Carbons (Tokyo)
Carbons (Tokyo)
see Tanso
Cardiologia
*Cardiologia *(Switzerland)*
Carnegie Inst. Wash., Pap. Geophys. Lab.
Carnegie Institution of Washington, Papers from the Geophysical Laboratory *(U. S.)*
Caryologia
*Caryologia *(Italy)*
Cas. Lek. Cesk.
Casopis Lekaru Ceskych *(Czechoslovakia)*
CEC (Consol. Electrodyn. Corp.) Rec.
CEC (Consolidated Electrodynamics Corporation) Recordings *(U. S.)*
Ceram. Age
*Ceramic Age *(U. S.)*
Cereal Chem.
*Cereal Chemistry *(U. S.)*
CERN Cour.
*CERN Courier *(Switzerland)*
Cesk. Cas. Fys.
*Ceskoslovensky Casopis pro Fysiku *(Czechoslovakia)*
Cesk. Farm.
Ceskoslovenska Farmacie *(Czechoslovakia)*
Cesk. Fysiol.
*Ceskoslovenska Fysiologie *(Czechoslovakia)*
Cesk. Gastroenterol. Vyz.
Ceskoslovenska Gastroenterologie a Vyziva, Sbornik pro Pathofysiologii Traveni a Vyzivy *(Czechoslovakia)*
Cesk. Hyg.
Ceskoslovenska Hygiena *(Czechoslovakia)*
Cesk. Neurol.
Ceskoslovenska Neurologie *(Czechoslovakia)*
Cesk. Oftalmol.
Ceskoslovenska Oftalmologie *(Czechoslovakia)*
Cesk. Radiol.
Ceskoslovenska Radiologie (formerly Ceskoslovenska Rentgenologie) *(Czechoslovakia)*
Cesk. Stomatol.
Ceskoslovenska Stomatologie *(Czechoslovakia)*
Chem. Anal. (Warsaw)
*Chemia Analityczna (Warsaw) *(Poland)*
Chem.-Analyst
*Chemist-Analyst, The *(U. S.)*
Chem. Ber.
*Chemische Berichte *(West Germany)*
Chem. Brit.
*Chemistry in Britain *(England)*
Chem. Bull. (Peking)
Chemical Bulletin (Peking)
see Hua Hsueh Tung Pao
Chem. Can.
*Chemistry in Canada *(Canada)*
Chem. Chem. Ind. (Tokyo)
Chemistry and Chemical Industry (Tokyo)
see Kagaku To Kogyo (Tokyo)
Chem. Commun.
*Chemical Communications *(England)*
Chem. Eng. (London)
*Chemical Engineer, The (London) *(England)*
Chem. Eng. (Tokyo)
Chemical Engineering (Tokyo)
see Kagaku Kogaku
Chem. Eng. News
Chemical Engineering News *(U. S.)*
Chem. Eng. Progr.
*Chemical Engineering Progress *(U. S.)*
Chem. Eng. Progr., Symp. Ser.
Chemical Engineering Progress, Symposium Series *(U. S.)*
Chem. Eng. Sci.
*Chemical Engineering Science *(U. S.)*
Chem. Erde
Chemie der Erde *(Germany)*
Chem. Geol.
Chemical Geology *(Netherlands)*
Chem. Ind.
Chemical Industry (Japan)
see Kagaku Kogyo
Chem. Ind. (London)
*Chemistry & Industry (London) *(England)*
Chem.-Ing.-Tech.
*Chemie-Ingenieur-Technik *(Germany)*
Chemistry (Taipei)
Chemistry (Taipei)
see Hua Hsueh
Chem. Listy
*Chemicke Listy *(Czechoslovakia)*
Chemotherapia
*Chemotherapia; International Journal of Experimental and Clinical Therapeutics *(Switzerland)*
Chem. Pharm. Bull. (Tokyo)
*Chemical and Pharmaceutical Bulletin (Tokyo) *(Japan)*
Chem. Phys. Lett.
*Chemical Physics Letters *(Netherlands)*
Chem. Process. (Chicago)
Chemical Processing (Chicago) *(U. S.)*
Chem. Process Eng.
*Chemical & Process Engineering (including Atomic World) *(England)*
Chem. Prumysl
Chemicky Prumysl *(Czechoslovakia)*
Chem. Rev.
*Chemical Reviews *(U. S.)*
Chem. Stosow., Ser. A
Chemia Stosowana, Seria A *(Poland)*
Chem. Stosow., Ser. B
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Chem. Tech. (Leipzig)
*Chemische Technik, VEB Deutscher Verlag fuer Grundstoffindustrie, Leipzig *(Germany)*
Chem. Weekbl.
Chemisch Weekblad *(Netherlands)*
Chem. World (Shanghai)
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see Hua Hsueh Shih Chieh
Chem. Zeit.
*Chemiker Zeitung *(West Germany)*

Chem. Zvesti
*Chemicke Zvesti *(Czechoslovakia)*
Chieh Pou Hsueh Pao
Chieh Pou Hsueh Pao (Acta Anatomica Sinica) *(China)*
Chih Wu Sheng Li Hsueh Pao
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Chim. Anal.
*Chimie Analytique (Paris) *(France)*
Chim. Chron. (Athens, Greece)
Chimika Chronika (Athens, Greece) *(Greece)*
Chimia (Aarau)
*Chimia (Aarau) *(Switzerland)*
Chim. Ind. (Milan)
*Chimica e l'Industria, la (Milan) *(Italy)*
Chim. Ind. (Paris)
*Chimie et Industrie (Paris) *(France)*
Chin. J. Ophthalmol.
Chinese Journal of Ophthalmology
see Chung Hua Yen K'o Tsa Chih
Chin. J. Otorhinolaryngol.
Chinese Journal of Otorhinolaryngology
see Chung Hua Erh Pi Yen Hou K'o Tsa Chih
Chin. J. Pediat.
Chinese Journal of Pediatrics
see Chung Hua Erh K'o Tsa Chih
Chin. J. Phys. (Taiwan)
*Chinese Journal of Physics (Taiwan) *(China)*
Chin. Med. J.
*Chinese Medical Journal, The *(China)*
Chin Shu Hsueh Pao
Chin Shu Hsueh Pao (Acta Metallurgica Sinica) *(China)*
Chirurg
Chirurg, Der *(West Germany)*
Chiryo
Chiryo (Therapy) (Journal of Therapy) *(Japan)*
Chishitsu Chosasho Geppo
Chishitsu Chosasho Geppo (Bulletin of the Geological Survey of Japan) *(Japan)*
Chishitsugaku Zasshi
Chishitsugaku Zasshi (Journal of the Geological Society of Japan) *(Japan)*
Chromatogr. Rev.
*Chromatoaraphic Reviews *(U. S.)*
Chromosoma
*Chromosoma *(Germany)*
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*Chubu Denryoku K. K. Kenkyu Shiryo (Memoirs of the Chubu Electric Power Co., Ltd.) *(Japan)*
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Chung Kuo K'o Hsueh
Chung Kuo K'o Hsueh
see Sci. Sinica (Peking)
Chung Kuo K'o Hsueh Yuan, Ying Yung Hua Hsueh Yen Chiu So Chi K'an
Chung Kuo K'o Hsueh Yuan, Ying Yung Hua Hsueh Yen Chiu So Chi K'an (Collected Papers of the Institute of Applied Chemistry, Chinese Academy of Sciences) *(China)*
Ciencia (Mexico)
*Ciencia (Mexico), Revista Hispano-Americana de Ciencias Puras y Applicadas *(Mexico)*
Cir. Cirujanos
Ciruaia y Cirujanos *(Mexico)*
Circulation
*Circulation *(U. S.)*
Cir. Ginecol. Urol.
Ciruaia, Ginecoloaia, y Urologia *(Spain)*
Cir. Res.
*Circulation Research *(U. S.)*
Clin. All-Round
Clinic All-Round
see Sogo Rinsho
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*Clinical Chemistry *(U. S.)*
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*Clinica Chimica Acta *(Netherlands)*
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*Clinical Obstetrics and Gynecology *(U. S.)*
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*Clinical Pediatrics (Philadelphia) *(U.S.)*
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*Clinical Pharmacology and Therapeutics *(U.S.)*
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*Clinical Radiology *(Scotland)*
Clin. Radiol. (Jap.)
Clinical Radiology (Japan)
see Rinsho Hoshasen
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*Clinical Science *(England)*
Cold Spring Harbor Symp. Quant. Biol.
*Cold Spring Harbor Symposia on Quantitative Biology *(U.S.)*
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*Collection of Czechoslovak Chemical Communications *(Czechoslovakia)*
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Collected Papers of the Institute of Applied Chemistry, Chinese Academy of Sciences
see Chung Kuo K'o Hsueh Yuan, Ying Yung Hua Hsueh Yen Chiu So Chi K'an
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*Combustion and Flame *(England)*
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*Comments on Nuclear and Particle Physics *(U. S.–England)*
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*Communications of the ACM (Association for Computing Machinery) *(U. S.)*
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*Communications in Mathematical Physics *(Germany)*
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*Communications on Pure and Applied Mathematics *(U. S.)*
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*Comitato Nazionale per l'Energia Nucleare, Notiziario *(Italy)*
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*Comparative Biochemistry and Physiology *(U.S.)*
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*Comptes Rendus Hebdomadaires des Seances de l'Academie des Sciences, Serie A, B *(France)*
Compt. Rend., Ser. C
*Comptes Rendus Hebdomadaires des Seances de l'Academie des Sciences, Serie C *(France)*
Compt. Rend., Ser. D
*Comptes Rendus Hebdomadaires des Seances de l'Academie des Sciences, Serie D *(France)*
Compt. Rend. Soc. Biol.
*Comptes Rendus des Seances de la Societe de Biologie et de ses Filiales *(France)*
Compt. Rend. Soc. Fr. Gynecol.
Comptes Rendus de la Societe Francaise de Gynecologie *(France)*
Compt. Rend. Trav. Lab. Carlsberg
Comptes Rendus des Travaux du Laboratoire Carlsberg *(Denmark)*
Comput. Automat.
*Computers and Automation *(U.S.)*
Comput. Bull.
*Computer Bulletin *(England)*
Comput. J.
*Computer Journal *(England)*
Concours Med.
Concours Medical *(France)*
Concrete Constr. Eng.
Concrete and Constructional Engineering *(England)*

Confin. Neurol.
*Confinia Neurologica: Borderland of Psychiatry *(Switzerland)*
Conn. Med.
Connecticut Medicine *(U. S.)*
Conserva (The Hague)
Conserva (The Hague) *(Netherlands)*
Construction (Paris)
Construction (Paris) *(France)*
Contemp. Phys.
*Contemporary Physics *(England)*
Contr. Eng.
*Control Engineering; Instrumentation and Automatic Control Systems *(U.S.)*
Contrib. Boyce Thompson Inst.
*Contributions from Boyce Thompson Institute *(U.S.)*
Contrib. Mineral. Petrol.
Contributions to Mineralogy and Petrology *(West Germany)*
Control
*Control *(England)*
Cornell Vet.
*Cornell Veterinarian, The *(U.S.)*
Corros. Anti-Corros.
Corrosion et Anti-Corrosion *(France)*
Corros. Eng. (Tokyo)
Corrosion Engineering (Tokyo)
see Boshoku Gijutsu
Corrosion
*Corrosion *(U. S.)*
Corros. Sci.
*Corrosion Science *(England–U. S.)*
Corros. Technol.
Corrosion Technology *(England)*
Corros.-Trait., Prot., Finition
*Corrosion-Traitements, Protection, Finition (formerly Corrosion et Anticorrosion) *(France)*
COSPAR (Comm. Space Res.) Inform. Bull.
COSPAR (Committee on Space Research) Information Bulletin *(Netherlands)*
Croat. Chem. Acta
*Croatica Chemica Acta *(Yugoslavia)*
Crop Sci.
Crop Science *(U. S.)*
Crops Soils
Crops and Soils *(U. S.)*
Cryobiology
*Cryobiology *(U. S.)*
Cryog. Eng. News
*Cryogenic Engineering News *(U. S.)*
Cryogenics
*Cryogenics *(England)*
Curr. Sci. (India)
*Current Science *(India)*
Curr. Ther. Res., Clin. Exp.
*Current Therapeutic Research, Clinical and Experimental *(U.S.)*
Cytogenetics
*Cytogenetics *(Switzerland)*
Cytologia (Tokyo)
*Cytologia (Tokyo) *(Japan)*
Czech. J. Phys.
*Czechoslovak Journal of Physics *(Czechoslovakia)*
Dan. Kemi
*Dansk Kemi *(Denmark)*
Dan. Tek. Tidsskr.
*Dansk Teknisk Tidsskrift *(Denmark)*
Dan. Tidsskr. Farm.
Dansk Tidsskrift for Farmaci *(Denmark)*
Data At. Power
Data of Atomic Power
see Genden Shiryo
DDZ (Das Deut. Zahnaerztebl.)
DDZ (Das Deutsche Zahnaerzteblatt) *(West Germany)*
Dechema Monogr.
Dechema Monographien *(West Germany)*
Deep-Sea Res. Oceanogr. Abstr.
*Deep-Sea Research and Oceanographic Abstracts (formerly Deep-Sea Research) *(England)*
Defektoskopiya
*Defektoskopiya *(U.S.S.R.)*
Def. Sci. J. (New Delhi)
Defence Science Journal (New Delhi) *(India)*
Denki Gakkai Zasshi
*Denki Gakkai Zasshi (The Journal of the Institute of Electric Engineers of Japan) *(Japan)*
Denki Kagaku
*Denki Kagaku (Journal of the Electrochemical Society of Japan) *(Japan)*
Denki Shikensho Iho
*Denki Shikensho Iho (Bulletin of the Electrotechnical Laboratory (Tokyo)) *(Japan)*
Denki Tsushin Gakkai Zasshi
Denki Tsushin Gakkai Zasshi (The Journal of the Inst. of Electrical Communication Engineers of Japan) *(Japan)*
Denki Tsushin Kenkyusho Kenkyu Jitsuyoka Hokuku
*Denki Tsushin Kenkyusho Kenkyu Jitsuyoka Hokuku (Electrical Communication Lab., Technical Journal) *(Japan)*
Denryoku
*Denryoku (Electric Power, Tokyo) *(Japan)*
Dent. Clin. N. Amer.
*Dental Clinics of North America *(U.S.)*
Dent. Dig.
Dental Digest *(U. S.)*
Dent. Pract. Dent. Rec.
Dental Practitioner and Dental Record *(England)*
Dent. Progr.
Dental Progress *(U. S.)*
Dermatologica
*Dermatologica *(Switzerland)*
Dermatol. Trop.
Dermatologia Tropica *(U. S.)*
Dermatol. Wochschr.
Dermatologische Wochenschrift *(Germany)*
Deut. Lebensm.-Rundsch.
Deutsche Lebensmittel-Rundschau *(Germany)*
Deut. Med. Wochschr.
*Deutsche Medizinische Wochenschrift *(Germany)*
Deut. Stomatol.
Deutsche Stomatologie *(Germany)*
Deut. Zahnaerztl. Z.
Deutsche Zahnaerztliche Zeitschrift *(Germany)*
Deut. Z. Verdau.- Stoffwechselkrankh.
Deutsche Zeitschrift fuer Verdauungs-und Stoffwechselkrankheiten *(Germany)*
Develop. Biol.
*Developmental Biology *(U. S.)*
DEW Tech. Ber.
DEW Technische Berichte *(West Germany)*
Diabetes
*Diabetes *(U.S.)*
Diabetologia
*Diabetologia *(U. S.–West Germany)*
Dis. Chest
*Diseases of the Chest *(U.S.)*
Dis. Colon Rectum
*Diseases of the Colon and Rectum *(U.S.)*
Discovery
Discovery *(England)*
Discuss. Faraday Soc.
*Discussions of the Faraday Society *(England)*
Disease-a-Month
Disease-a-Month *(U. S.)*
Dis. Nerv. Syst.
*Diseases of the Nervous System *(U.S.)*
Diss. Pharm.
Dissertationes Pharmaceuticae *(Poland)*
Diss. Pharm. Pharmacol.
*Dissertationes Pharmaceuticae et Pharmacologicae *(Poland)*
Doboku Gakkaishi
*Doboku Gakkaishi (Journal of the Japan Society of Civil Engineers) *(Japan)*
Dobutsugaku Zasshi
*Dobutsugaku Zasshi (Zoological Magazine) *(Japan)*
Doc. Ophthalmol.
*Documenta Ophthalmologica *(Netherlands)*
Doitai To Hoshasen
*Doitai To Hoshasen (Isotopes and Radiation) *(Japan)*
Dokl. Akad. Nauk Arm. SSR
*Doklady Akademii Nauk Armyanskoi SSR *(Armenian S.S.R.)*
Dokl. Akad. Nauk Azerb. SSR
Doklady Akademii Nauk Azerbaidzhanskoi SSR *(Azerbaidzhan S.S.R.)*
Dokl. Akad. Nauk Belorussk. SSR
Doklady Akademii Nauk Belorusskoi SSR *(Belorussian S.S.R.)*
Dokl. Akad. Nauk BSSR

*Doklady Akademii Nauk BSSR (formerly Doklady Akademii Nauk Belorusskoi SSR) *(Belorussian S.S.R.)*
Dokl. Akad. Nauk SSSR
*Doklady Akademii Nauk SSSR† *(U.S.S.R.)*
Dokl. Akad. Nauk Tadzh. SSR
*Doklady Akademii Nauk Tadzhikskoi SSR *(Tadzhik S.S.R.)*
Dokl. Akad. Nauk Uzb. SSR
*Doklady Akademii Nauk Uzbekskoi SSR *(Uzbek S.S.R.)*
Dokl., Earth Sci. Sect. (Engl. Transl.)
Doklady, Earth Sciences Sections (English Translation) *(U. S.)*
Dokl. Vses. Akad. Sel'skokhoz. Nauk
Doklady Vsesovuznoi Akademii Sel'skokhozyaistvennykh Nauk imeni V. I. Lenina *(U.S.S.R.)*
Dopov. Akad. Nauk Ukr. RSR
Dopovidi Akademii Nauk Ukrains'koi RSR *(Ukrainian S.S.R.)*
Dopov. Akad. Nauk Ukr. RSR, Ser. A
*Dopovidi Akademii Nauk Ukrains'koi RSR, Seriya A. Fiziko-Tekhnichni i Matematichni Nauki (supersedes in part Dopovidi Akademii Nauk Ukrains'koi RSR) *(Ukrainian S.S.R.)*
Dopov. Akad. Nauk Ukr. RSR, Ser. B
*Dopovidi Akademii Nauk Ukrains'koi RSR, Seriya B. Geologiya, Geofizika, Khimiya i Biologiya (supersedes in part Dopovidi Akademii Nauk Ukrains'koi RSR) *(Ukrainian S.S.R.)*
Drug Cosmet. Ind.
*Drug and Cosmetic Industry *(U.S.)*
Duke Math. J.
*Duke Mathematical Journal *(U.S.)*
Duodecim
Duodecim *(Finland)*
Dyna
Dyna *(Spain)*
Earth Planet. Sci. Lett.
*Earth and Planetary Science Letters *(Netherlands)*
East Eur. Sci. Abstr.
East European Scientific Abstracts *(U. S.)*
Ebara Times
Ebara Times
see Ebara Jiho
Ecol. Monogr.
*Ecological Monographs *(U.S.)*
Ecology
*Ecology *(U. S.)*
Econ. Geol.
*Economic Geology and the Bulletin of the Society of Economic Geologists *(U. S.)*
Educ. Chem.
*Education in Chemistry *(England)*
EEI (Edison Elec. Inst.) Bull.
EEI (Edison Electric Institute) Bulletin *(U. S.)*
Effluent Water Treat. J.
Effluent and Water Treatment Journal *(England)*
Ehara Jiho
*Ehara Jiho (Ebara Times) *(Japan)*
Eisei Kagaku
Eisei Kagaku (The Journal of Hygienic Chemistry) *(Japan)*
Eisei Shikensho Hokoku
Eisei Shikensho Hokoku (Bulletin of National Institute of Hygenic Sciences) *(Japan)*
Ekol. Pol., Ser. B
Ekologia Polska, Seria B *(Poland)*
Eksp. Khir. Anesteziol.
Eksperimental'naya Khirurgia i Anesteziologiya *(U.S.S.R.)*
Eksp. Med. Morfol.
Eksperimentalna Meditsina i Morfologiya *(Bulgaria)*
Elec. Commun. Lab., Tech. J.
Electrical Communication Laboratory, Technical Journal
see Denki Tsushin Kenkyusho Kenkyu Jitsuyoka Hokoku
Elec. Eng. Jap. (Engl. Transl.)
Electrical Engineering in Japan (English Translation of Denki Gakkai Zasshi) *(U. S.)*
Elec. Export Rev.
Electrical Export Review *(England)*
Elec. Mag. OHM
The Electrical Magazine OHM
see OHM
Elec. Power, Tokyo
Electric Power, Tokyo
see Denryoku
Elec. Rev.
*Electrical Review *(England)*
Elec. Times
Electrical Times *(England)*
Electricite
*Electricite *(France)*
Electrochem. Technol.
*Electrochemical Technology *(U. S.)*
Electrochim. Acta
*Electrochimica Acta *(England–U. S.)*
Electroencephalogr. Clin. Neurophysiol.
*Electroencephalography and Clinical Neurophysiology *(Canada)*
Electron. Appl.
*Electronic Applications, Components and Materials, including Matronics *(Netherlands)*
Electron. Commun. Jap. (Engl. Transl.)
*Electronics and Communications in Japan (English Translation of Denki Zusshin Gakkai Zasshi) *(U. S.)*
Electron. Design
*Electronic Design *(U.S.)*
Electron. Eng.
*Electronic Engineering Incorporating Electronics, Television and Short Wave World *(England)*
Electronics
Electronics *(U. S.)*
Electronics (Jap.)
Electronics (Japan)
see Erekutoronikusu
Electron. Ind.
Electronic Industries *(U. S.)*
Electron. Lett.
*Electronics Letters *(England)*
Electron. Power
*Electronics and Power *(England)*
Electron. Rec.
Electronics Record *(England)*
Electro-Technol. (N. Y.)
Electro-Technology (New York) *(U. S.)*
Electrotehnica (Bucharest)
*Electrotehnica (Bucharest) *(Romania)*
Elec. World
Electrical World *(U. S.)*
Elektrichestvo
Elektrichestvo† *(U.S.S.R.)*
Elektrokhimiya
Elektrokhimiya *(U.S.S.R.)*
Elektromed. Ihre Grenz.
Elektromedizin und Ihre Grenzgebiete *(Germany)*
Elektrosvyaz
*Elektrosvyaz; Nauchno-Tekhnicheskii Zhurnal *(U.S.S.R.)*
Elektrotech. Maschinenbau
Elektrotechnik und Maschinenbau *(West Germany)*
Elektrotech. Obz.
Elektrotechniky Obzor *(Czechoslovakia)*
Elektrotech. Z., A
Elektrotechnische Zeitschrift, A *(West Germany)*
Elektrotech. Z., B.
*Elektrotechnische Zeitschrift, B *(West Germany)*
Elektrotek. Tidsskr.
*Elektroteknisk Tidsskrift *(Norway)*
Elettrotecnica
*Elettrotecnica, L' *(Italy)*
Elettrotecnica, Suppl.
*Elettrotecnica, L', Supplemento *(Italy)*
Embryologia (Nagoya)
*Embryologia (Nagoya) *(Japan)*
Endeavour
*Endeavour *(England)*
Endocrinol. Jap.
*Endocrinologia Japonica *(Japan)*
Endocrinology
*Endocrinology *(U. S.)*
Endokrinologie
*Endokrinologie *(East Germany)*
Endokrynol. Pol.
Endokrynologia Polska *(Poland)*
Energ. Atomtech.
*Energia es Atomtechnika *(Hungary)*
Energiewirtsch. Tagesfragen
Energiewirtschaftliche Tagesfragen *(Germany)*
Energ. Nucl. (Madrid)
*Energia Nuclear (Madrid) *(Spain)*
Energ. Nucl. (Milan)
*Energia Nucleare (Milan) *(Italy)*
Energ. Nucl. (Paris)

*Energie Nucleaire (Paris) *(France)*
Energy Int.
Energy International *(England)*
Eng. Boiler House Rev.
Engineering and Boiler House Review *(England)*
Eng. Dig. (Toronto)
*Engineering Digest (Toronto) *(Canada)*
Engelhard Ind., Tech. Bull.
*Engelhard Industries, Inc., Technical Bulletin *(U.S.)*
Engineer
*Engineer, The *(England)*
Engineering
*Engineering *(England)*
Eng. J. (Montreal)
*Engineering Journal, The (Montreal) *(Canada)*
Eng. Mater.
Engineering Materials
see Kogyo Zairyo
Eng. Mater. Des.
*Engineering Materials and Design *(England)*
Eng. Mining J.
*Engineering and Mining Journal *(U. S.)*
Enka Biniiru To Pomria
*Enka Biniiru To Pomria (Enka-Vinyl and Polymer) *(Japan)*
Enka-Vinyl. Polyn.
Enka-Vinyl and Polymer
see Enka Biniiru To Pomria
Entomol. Exp. Appl.
Entomologia Experimentalis et Applicata *(Netherlands)*
Entomol. Obozrenie
Entomolgicheskoe Obozrenie *(U.S.S.R.)*
Entomol. Rev. (USSR) (Engl. Transl.)
Entomological Revue (USSR) (English Translation of Entomolo-gicheskoe Obozrenie) *(U. S.)*
Environ. Quart.
*Environmental Quarterly *(U.S.)*
Environ. Sci. Technol.
*Environmental Science and Technology *(U. S.)*
Enzymol. Biol. Clin.
*Enzymologia Biologica et Clinica *(Netherlands)*
Enzymologia
*Enzymologia, Acta Biocatalytica *(Netherlands)*
Erdoel Kohle-Erdgas-Petrochem.
*Erdoel und Kohle-Erdgas-Petrochemie *(West Germany)*
Erekutoronikusu
*Erekutoronikusu (Electronics) *(Japan)*
Ergeb. Allgem. Pathol. Pathol. Anat.
Ergebnisse der Allgemeinen Pathologie und Pathologischen Anatomie *(Germany)*
Ergeb. Chir. Orthopaed.
Ergebnisse der Chirurgie und Orthopaedie *(Germany)*
Ergeb. Physiol. Biol. Chem. Exp. Pharmakol.
*Ergebnisse der Physiologie, Biologischen Chemie und Experimentellen Pharmakologie *(Germany)*
Ericsson Tech.
Ericsson Technics *(Sweden)*
Eugen. Quart.
*Eugenics Quarterly *(U.S.)*
Euphytica
*Euphytica *(Netherlands)*
Euratom Bull.
*Euratom Bulletin (Bulletin of the European Atomic Energy Community) *(Netherlands)*
Eur. J. Biochem.
*European Journal of Biochemistry *(U. S.—West Germany)*
Eur. J. Cancer
*European Journal of Cancer *(England)*
EuroNuclear
EuroNuclear *(England)*
Eur. Polym. J.
European Polymer Journal *(England)*
Evolution
*Evolution, International Journal of Organic Evolution *(U.S.)*
Excerpta Med. Int. Congr. Ser.
Excerpta Medica, International Congress Series *(Netherlands)*
Exp. Agr.
*Experimental Agriculture *(England)*
Exp. Brain Res.
*Experimental Brain Research *(West Germany)*
Exp. Cell Res.
*Experimental Cell Research *(U. S.)*
Experientia
*Experientia *(Switzerland)*
Exp. Eye Res.
*Experimental Eye Research *(England)*
Exp. Gerontol.
Experimental Gerontology *(U. S.)*
Explosivstoffe
Explosivstoffe *(Germany)*
Exp. Mech.
Experimental Mechanics *(U. S.)*
Exp. Med. Surg.
*Experimental Medicine and Surgery *(U.S.)*
Exp. Mol. Pathol.
*Experimental and Molecular Pathology *(U. S.)*
Exp. Neurol.
*Experimental Neurology *(U. S.)*
Exp. Parasitol.
*Experimental Parasitology *(U.S.)*
Exp. Tech. Phys.
*Experimentelle Technik der Physik *(Germany)*
Eye, Ear, Nose, Throat Mon.
*Eye, Ear, Nose, and Throat Monthly, The *(U.S.)*
Ezhegodnik, Inst. Eksperim. Med. Akad. Med. Nauk SSSR
Ezhegodnik, Institut Eksperimental'noi Meditsiny Akademii Meditsinskikh Nauk SSSR *(U.S.S.R.)*
Fachbuchreihe Schweisstech.
Fachbuchreihe Schweisstechnik *(West Germany)*
FAPIG (Tokyo)
*FAPIG (Tokyo) *(Japan)*
Farm. (Pavia) Ed. Prat.
*Farmaco, il (Pavia), Edizione Pratica *(Italy)*
Farm. (Pavia) Ed. Sci.
*Farmaco, il (Pavia), Edizione Scientifica *(Italy)*
Farmakol. Toksikol.
*Farmakologiya i Toksikologiya *(U.S.S.R.)*
Fed. Proc.
*Federation Proceedings *(U. S.)*
Fed. Proc., Transl. Suppl.
Federation Proceedings, Translation Supplement *(U. S.)*
Femipari Kut. Intez. Kozlem.
*Femipari Kutato Intezet Kozlemenyei, A *(Hungary)*
Fermelde-Praxis
Fermelde-Praxis *(West Germany)*
Fertigungstech. Betr.
Fertigungstechnik und Betrieb *(East Germany)*
Fertil. Steril.
*Fertility and Sterility *(U.S.)*
Filtr. Sep.
Filtration and Separation *(England)*
Finommechanika
Finommechanika *(Hungary)*
Finska Kemistsamfundets Medd.
*Finska Kemistsamfundets Meddelanden *(Finland)*
Fiz. Elektron., Mosk. Inzh.-Fiz. Inst.
Fizicheskaya Elektronika, Moskovskii Inzhenerno-Fizicheskii Institut *(U.S.S.R.)*
Fiz. Goreniya Vzryva
Fizika Goreniya i Vzryva *(U.S.S.R.)*
Fiziol. Zh., Akad. Nauk Ukr. RSR
*Fiziologichnii Zhurnal, Akademiya Nauk Ukrains'koi RSR *(Ukrainian S.S.R.)*
Fiziol. Zh. SSSR
Fiziologicheskii Zhurnal SSSR imeni I. M. Sechenova† *(U.S.S.R.)*
Fiz.-Khim. Mekh. Mater.
*Fiziko-Khimicheskaya Mekhanika Materialov *(Ukrainian S.S.R.)*
Fiz. Metal. Metalloved.
*Fizika Metallov i Metallovedeniya, Akademiya Nauk SSSR, Ural'skii Filial† *(U.S.S.R.)*
Fiz. Szemle
*Fizikai Szemle *(Hungary)*
Fiz. Tverd. Tela
*Fizika Tverdogo Tela *(U.S.S.R.)*
Fla. Entomol.
Florida Entomologist, The *(U. S.)*
Fleischwirtschaft
Fleischwirtschaft, Die *(West Germany)*
Flora (Jena)
Flora oder Allgemeine Botanische Zeitung (Jena) *(Germany)*
Flugwelt
*Flugwelt; Monatszeitschrift fuer Luft-und Raumfahrt *(West Germany)*
Fluoric Chem.

Fluoric Chemistry
see **Fusso Kagaku**

Folia Biol. (Prague)
*Folia Biologica (Prague) *(Czechoslovakia)*

Folia Biol. (Warsaw)
*Folia Biologica (Warsaw) *(Poland)*

Folia Clin. Int.
Folia Clinica Internacional *(Spain)*

Folia Endocrinol. Jap.
Folia Endocrinologica Japonica
see **Nippon Naibunpi Gakkai Zasshi**

Folia Endocrinol. (Pisa)
Folia Endocrinologica (Pisa) *(Italy)*

Folia Haematol. (Frankfurt)
Folia Haematologica (Frankfurt) *(Germany)*

Folia Haematol. (Leipzig)
Folia Haematologica (Leipzig) *(Germany)*

Folia Med. (Naples)
*Folia Medica (Naples) *(Italy)*

Folia Med. (Plovdiv)
Folia Medica (Plovdiv) *(Bulgaria)*

Folia Microbiol. (Prague)
*Folia Microbiologica (Prague) *(Czechoslovakia)*

Folia Morphol.
Folia Morphologica *(Poland)*

Folia Ophthalmol. Jap.
Folia Ophthalmologica Japonica
see **Nippon Ganka Kiyo**

Folia Primatol.
*Folia Primatologica *(Switzerland)*

Food Cosmet. Toxicol.
*Food and Cosmetics Toxicology *(England)*

Food Irradiat.
*Food Irradiation *(France)*

Food Technol.
*Food Technology *(U. S.)*

Forest. Chron.
Forestry Chronicle *(Canada)*

Forest Prod. J.
Forest Products Journal *(U. S.)*

Forest Sci.
Forest Science *(U. S.)*

Forschungsber. Landes Nordrhein-Westfalen
Forschungsberichte des Landes Nordrhein-Westfalen *(West Germany)*

Fortschr. Chem. Forsch.
Fortschritte der Chemischen Forschung *(Germany)*

Fortschr. Chem. Org. Naturst.
*Fortschritte der Chemie Organischer Naturstoffe *(Austria)*

Fortschr. Geb. Roentgenstr. Nuklearmed.
*Fortschritte auf dem Gebiete der Roentgenstrahlen und der Nuklearmedizin, Diagnostik, Physik, Biologie, Therapie *(Germany)*

Fortschr. Geburtshilfe Gynaekol.
*Fortschritte der Geburtshilfe und Gynaekologie *(Switzerland)*

Fortschr. Kiefer- Gesichtschir.
Fortschritte der Kiefer- und Gesichtschirurgie *(Germany)*

Fortschr. Med.
Fortschritte der Medizin *(Germany)*

Fortschr. Mineral.
Fortschritte der Mineralogie *(West Germany)*

Fortschr. Phys.
*Fortschritte der Physik *(Germany)*

Fra Fys. Verden
*Fra Fysikkens Verden *(Norway)*

Frankfurt. Z. Pathol.
Frankfurter Zeitschrift fuer Pathologie *(West Germany)*

Fuel
*Fuel, A Journal of Fuel Science *(England)*

Fuji Jiho
*Fuji Jiho (Fuji Electric Journal) *(Japan)*

Fund. Balneo-Bioclimatol.
Fundamenta Balneo-Bioclimatologica *(West Germany)*

Funtai Oyobi Funmatsuyakin
*Funtai Oyobi Funmatsuyakin (Journal of the Japan Society of Powder Metallurgy) *(Japan)*

Furukawa Denko Jiho
Furukawa Denko Jiho (Furukawa Electric Review) *(Japan)*

Furukawa Elec. Rev.
Furukawa Electric Review, The
see **Furukawa Denko Jiho**

Fusso Kagaku
Fusso Kagaku (Fluoric Chemistry) *(Japan)*

Fysiat. Reumatol. Vestn.
Fysiatricky a Reumatologicky Vestnik (formerly Fysiatricky Vestnik) *(Czechoslovakia)*

Fys. Tidsskr.
*Fysisk Tidsskrift *(Denmark)*

Fyz. Cas.
Fyzikalny Casopis, Vydavatel'stvo Slovenskej Akademie Vied *(Czechoslovakia)*

Gac. Ortoped. Traumatol.
Gaceta Ortopedia y Traumatologia *(Mexico)*

Gac. Vet. (Buenos Aires)
Gaceta Veterinaria (Buenos Aires) *(Argentina)*

Gakujutsu Geppo
*Gakujutsu Geppo (Japanese Scientific Monthly) *(Japan)*

Gamma Field Symp.
*Gamma Field Symposia *(Japan)*

Gann
*Gann *(Japan)*

Gan no Rinsho
Gan no Rinsho (Japanese Journal of Cancer Clinics) *(Japan)*

Gastroenterologia
*Gastroenterologia *(Switzerland)*

Gastroenterology
*Gastroenterology *(U.S.)*

Gas- Wasserfach
Gas- und Wasserfach, Das *(West Germany)*

Gaz. Med. France
Gazette Medicale de France *(France)*

Gazov. Prom.
Gazovaya Promyshlennost *(U.S.S.R.)*

Gazz. Chim. Ital.
*Gazzetta Chimica Italiana *(Italy)*

Gazz. Int. Med. Chir.
Gazzetta Internazionale di Medicina e Chirurgia *(Italy)*

Gazz. Med. Sicil.
Gazzetta Medica Siciliana *(Italy)*

Gazz. Sanit.
Gazzetta Sanitaria *(Italy)*

G. Bot. Ital.
Giornale Botanico Italiano (formerly Nuovo Giornale Botanico Italiano (Nuova Serie)) *(Italy)*

Geburtsh. Frauenheilk.
Geburtshilfe und Frauenheilkunde *(Germany)*

G.E.C.J. Sci. Tech.
*G. E. C. Journal of Science and Technology *(England)*

Geliotekh., Akad. Nauk Uzb. SSR
Geliotekhnika, Akademiya Nauk Uzbekskoi SSR *(Uzbek S.S.R.)*

G.E.N. (Caracas)
G.E.N. (Caracas) *(Venezuela)*

Gencho Hiroshima Igaku
Gencho Hiroshima Igaku (The Hiroshima Medical Journal) *(Japan)*

Gen. Comp. Endocrinol.
*General and Comparative Endocrinology *(U. S.)*

Genden Shiryo
*Genden Shiryo (Data of Atomic Power) *(Japan)*

Genet. Agr.
Genetica Agraria *(Italy)*

Genet. Iber.
*Genetica Iberica *(Spain)*

Genetica
*Genetica *(Netherlands)*

Genetics
*Genetics *(U. S.)*

Genetika
*Genetika *(U.S.S.R.)*

Genet. Pol.
*Genetica Polonica *(Poland)*

Genet. Psychol. Monogr.
*Genetic Psychology Monographs; Child Behavior, Animal Behavior and Comparative Psychology *(U.S.)*

Genet. Res.
*Genetical Research *(England)*

Genet. Slechteni
Genetika a Slechteni *(Czechoslovakia)*

Genie Chim.
Genie Chimique (Supplement mensuel a Chimie & Industrie) *(France)*

Genie Civil
Genie Civil, Le *(France)*

Gensen-Kyo

*Gensen-Kyo *(Japan)*
Genshikaku Kenkyu
*Genshikaku Kenkyu *(Japan)*
Genshi Nenryo Kosha Nempo
Genshi Nenryo Kosha Nempo (Annual Report of the Nuclear Fuel Corporation) *(Japan)*
Genshiroyoku Chosa Jiho
*Genshiroyoku Chosa Jiho (Review of Atomic Industries) *(Japan)*
Genshiryoku Hatsuden
Genshiryoku Hatsuden (Nuclear Power) *(Japan)*
Genshiryoku Kogyo
*Genshiryoku Kogyo (Nuclear Engineering) *(Japan)*
Geochem. Int. (Engl. Transl.)
*Geochemistry International (English Translation of selected articles from Geokhimiya together with selected translated geochemical papers from other languages) *(U. S.)*
Geochem. J. (Nagoya)
Geochemical Journal (Nagoya) *(Japan)*
Geochim. Cosmochim. Acta
*Geochimica et Cosmochimica Acta *(England)*
Geoexploration (Trondheim)
Geoexploration (Trondheim) *(Norway)*
Geofis. Int.
Geofisica Internacional *(Mexico)*
Geofis. Meteorol. (Genoa)
*Geofisica e Meteorologia (Genoa) *(Italy)*
Geofiz. Astron. Inform. Byull.
Geofizika i Astronomiya, Informatsionnyi Byulleten *(Ukrainian S.S.R.)*
Geofiz. Kozlem.
*Geofizikai Kozlemenyek *(Hungary)*
Geofiz. Sb., Akad. Nauk Ukr. SSR, Inst. Geofiz.
Geofizicheskii Sbornik, Akademiya Nauk Ukrainskoi SSR, Institut Geofiziki *(Ukrainian S.S.R.)*
Geokhimiya
*Geokhimiyat *(U.S.S.R.)*
Geol. Foren. Stockholm Forh.
Geologiska Foreningens i Stockholm Forhandlingar *(Sweden)*
Geol. Mijnbouw
Geologie en Mijnbouw *(Netherlands)*
Geol. Rudn. Mestorozhd.
Geologiya Rudnykh Mestorozhdenii, Akademiya Nauk SSSR *(U.S.S.R.)*
Geol. Rundsch.
*Geologische Rundschau *(West Germany)*
Geol. Soc. Amer., Bull.
*Geological Society of America, Bulletin *(U. S.)*
Geomagn. Aeronomiya
*Geomagnetizm i Aeronomiyat *(U.S.S.R.)*
Geomagn. Aeronomy (USSR) (Engl. Transl.)
Geomagnetism and Aeronomy (USSR) (English Translation of Geomagnetizm i Aeronomiya) *(U. S.)*
Geophys. Explor.
Geophysical Exploration
see Butsuri Tanko
Geophysica
Geophysica *(Finland)*
Geophysics
*Geophysics *(U. S.)*
Geophys. J.
*Geophysical Journal *(England)*
Geophys. J. Roy. Astron. Soc.
Geophysical Journal of the Royal Astronomical Society *(England)*
Geophys. Mag. (Tokyo)
Geophysical Magazine (Tokyo) *(Japan)*
Geophys. Space Data Bull.
*Geophysics and Space Data Bulletin *(U. S.)*
Geotektonika
*Geotektonika *(U.S.S.R.)*
Ger. Med. Mon.
*German Medical Monthly *(West Germany)*
G. Fis. Soc. Ital. Fis.
Giornale di Fisica della Societa Italiana di Fisica *(Italy)*
G. Gerontol.
Giornale di Gerontologia *(Italy)*
Giessereipraxis
Giessereipraxis *(Germany)*
G. Ig. Med. Prevent.
Giornale di Igiene e Medicina Preventiva *(Italy)*
Gig. Sanit.
*Gigiena i Sanitariya *(U. S. S. R.)*
Gig. Tr. Prof. Zabol.
Gigiena Truda i Professional'nye Zabolevaniya *(U.S.S.R.)*
Giho (Boeicho Gijutsu Kenkyu Honbu)
*Giho (Boeicho Gijutsu Kenkyu Honbu) (Research and Development Headquarters, Japan Defense Agency) *(Japan)*
Giho, Res. Dev. Headquarters, Jap. Defense Agency
Giho, Research and Development Headquarters, Japan Defense Agency
see Giho Boeicho Gijutsu Kenkyu Honbu
Gijutsu Kenkyusho Shoho
*Gijutsu Kenkyusho Shoho (Journal of the Technical Laboratory) *(Japan)*
Ginecol. Obstet. Mex.
Ginecologia y Obstetricia de Mexico *(Mexico)*
Ginekol. Pol.
Ginekologia Polska *(Poland)*
G. Ital. Chemioter.
Giornale Italiano di Chemioterapia *(Italy)*
G. Ital. Chir.
Giornale Italiano di Chirurgia *(Italy)*
Gladiolus
Gladiolus *(U. S.)*
Glas-Email-Keramo-Tech.
Glas-Email-Keramo-Technik *(West Germany)*
Glas. Hem. Drus., Beograd
*Glasnik Hemiskog Drustva, Beograd *(Yugoslavia)*
Glas. Hemicara Tehnol. Bosne Hercegovine
Glasnik Hemicara i Tehnologa Bosne i Hercegovine *(Yugoslavia)*
Glas. Mat.
*Glasnik Matematicki *(Yugoslavia)*
Glas. Mat.-Fiz. Astron., Ser. II
Glasnik Matematicko-Fizicki i Astronomski, Serija II *(Yugoslavia)*
Glass Technol.
*Glass Technology *(England)*
Glueckauf
Glueckauf *(West Germany)*
G. Med. Mil.
Giornale di Medicina Militare *(Italy)*
G. Microbiol.
*Gironale di Microbiologia *(Italy)*
GP, J. Amer. Acad. Gen. Pract.
*GP, Journal of the American Academy of General Practice *(U. S.)*
Growth
*Growth *(U. S.)*
Grundforbattring
Grundforbattring *(Sweden)*
Gunma J. Med. Sci.
Gunma Journal of Medical Sciences, The *(Japan)*
Gut
*Gut. (British Society of Gastroenterology) *(England)*
Guy's Hosp. Rep.
Guy's Hospital Reports *(England)*
Gynaecologia
*Gynaecologia *(Switzerland)*
Gyogyszereszet
Gyogyszereszet *(Hungary)*
Haematol. Lat. (Milan)
Haematologica Latina (Milan) *(Italy)*
Haematologica (Pavia)
Haematologica (Pavia) *(Italy)*
Haarterei-Tech. Mitt.
Haarterei-Technische Mitteilungen *(West Germany)*
Hakko Kogaku Zasshi
*Hakko Kogaku Zasshi (Journal of Fermentation Technology) *(Japan)*
Hakko Kyokaishi
Hakko Kyokaishi (Journal of the Fermentation Association of Japan) *(Japan)*
Hansa
Hansa. Zentralorgan fuer Schiffahrt-Schiffbau-Hafen *(West Germany)*
Harvard Public Health Alumni Bull.
Harvard Public Health Alumni Bulletin *(U. S.)*
Hautarzt
Hautarzt, Der *(Austria)*
Health Phys.
*Health Physics *(U. S.-England)*
Heart Bull.

Heart Bulletin, The *(U. S.)*

Heating, Piping Air Conditioning
Heating, Piping and Air Conditioning *(U. S.)*

Helv. Chim. Acta
*Helvetica Chimica Acta *(Switzerland)*

Helv. Chir. Acta
*Helvetica Chirurgica Acta *(Switzerland)*

Helv. Med. Acta
*Helvetica Medica Acta *(Switzerland)*

Helv. Med. Acta. Suppl.
*Helvetica Medica Acta, Supplementum *(Switzerland)*

Helv. Odont. Acta
Helvetica Odontologica Acta *(Switzerland)*

Helv. Paediat. Acta
*Helvetica Paediatrica Acta *(Switzerland)*

Helv. Phys. Acta
*Helvetica Physica Acta *(Switzerland)*

Helv. Physiol. Pharmacol. Acta
*Helvetica Physiologica et Pharmacologica Acta *(Switzerland)*

Helv. Physiol. Pharmacol. Acta, Suppl.
*Helvetica Physiologica et Pharmacologica Acta, Supplementum *(Switzerland)*

Hemostase
*Hemostase *(France)*

Hereditas
*Hereditas *(Sweden)*

Heredity
*Heredity *(England)*

Herpetologica
Herpetologica *(U. S.)*

Higijena
Higijena *(Yugoslavia)*

Hi-hakai Kensa
*Hi-hakai Kensa (Journal of N.D.I.) *(Japan)*

Hilgardia
Hilgardia *(U. S.)*

Hindustan Antibiot. Bull.
Hindustan Antibiotics Bulletin *(India)*

Hinyokika Kiyo
Hinyokika Kiyo (Acta Urological Japonica) *(Japan)*

Hippokrates (Stuttgart)
Hippokrates (Stuttgart) *(Germany)*

Hirosaki Igaku
*Hirosaki Igaku (The Hirosaki Medical Journal) *(Japan)*

Hirosaki Med. J.
Hirosaki Medical Journal, The
see Hirosaki Igaku

Hiroshima Daigaku Igaku Zasshi
*Hiroshima Daigaku Igaku Zasshi (Medical Journal of Hiroshima University) *(Japan)*

Hiroshima Igaku
Hiroshima Igaku (The Journal of the Hiroshima Medical Association) *(Japan)*

Hiroshima J. Med. Sci.
*Hiroshima Journal of Medical Sciences *(Japan)*

Hiroshima Med. J.
Hiroshima Medical Journal, The
see Gencho Hiroshima Igaku

Histochemie
*Histochemie *(Germany)*

Hitachi Hyoron
*Hitachi Hyoron (Hitachi Review) *(Japan)*

Hitachi Zosen Giho
*Hitachi Zosen Giho (The Hitachi Zosen Technical Review) *(Japan)*

Hitachi Zosen Tech. Rev.
Hitachi Zosen Technical Review, The
see Hitachi Zosen Giho

Hochfrequenztech. Elektroakust.
Hochfrequenztechnik und Elektroakustik *(East Germany)*

Hodowla Rosl., Aklim. Nasien.
Hodowla Roslin, Aklimatyzacja i Nasiennictwo *(Poland)*

Holztechnologie
Holztechnologie *(Germany)*

Hoshasen Igaku Seibutsugaku
Hoshasen Igaku Seibutsugaku (The Nihon University Journal of Radiation Medicine and Biology) *(Japan)*

Hoshasen Kobunshi
*Hoshasen Kobunshi (Radiation Research on Polymers) *(Japan)*

Hosp. Progr.
Hospital Progress *(U. S.)*

Ho Tsu K'o Hsueh
*Ho Tsu K'o Hsueh (Nuclear Science) *(China)*

Hua Hsueh
Hua Hsueh (Chemistry (Taipei)) *(China)*

Hua Hsueh Hsueh Pao
Hua Hsueh Hsueh Pao (Acta Chimica Sinica) *(China)*

Hua Hsueh Shih Chieh
Hua Hsueh Shih Chieh (Chemical World (Shanghai)) *(China)*

Hua Hseuh Tung Pao
Hua Hseuh Tung Pao (Chemical Bulletin) *(China)*

Huaxue Tongbao
Huaxue Tongbao
see Hua Hseuh Tung Pao

Hum. Biol.
*Human Biology *(U.S.)*

Hum. Factors
*Human Factors *(U. S.)*

Hutn. Listy
Hutnicke Listy *(Czechoslovakia)*

Hydraul. Pneum.
*Hydraulics and Pneumatics *(U.S.)*

Hydrobiologia
Hydrobiologia *(Netherlands)*

Ibaraki Daigaku Nogakubu Gakujutsu Hokoku
*Ibaraki Daigaku Nogakubu Gakujutsu Hokoku (Scientific Reports of the Faculty of Agriculture, Ibaraki University) *(Japan)*

IBM J. Res. Develop.
*IBM Journal of Research and Development *(U. S.)*

I-CAN (Int.-Chromosome Anal. Newslett.)
*I–CAN (International–Chromosome Analysis Newsletter) *(Austria)*

Icarus
*Icarus. International Journal of the Solar System *(U. S.–England)*

Ideggyogy. Szemle
Ideggyogyaszati Szemle *(Hungary)*

Idengaku Zasshi
*Idengaku Zasshi (Japanese Journal of Genetics) *(Japan)*

Idojaras
Idojaras *(Hungary)*

IEEE (Inst. Elec. Electron. Eng.) J. Quantum Electron.
*IEEE (Institute of Electrical and Electronics Engineers) Journal of Quantum Electronics *(U. S.)*

IEEE (Inst. Elec. Electron. Eng.) J. Solid-State Circuits
*IEEE (Institute of Electrical and Electronics Engineers) Journal of Solid-State Circuits *(U. S.)*

IEEE (Inst. Elec. Electron. Eng.), Spectrum
*IEEE (Institute of Electrical and Electronics Engineers), Spectrum *(U. S.)*

IEEE (Inst. Elec. Electron. Eng.), Trans. Aerospace Electron. Syst.
*IEEE (Institute of Electrical and Electronics Engineers), Transactions on Aerospace and Electronic Systems *(U.S.)*

IEEE (Inst. Elec. Electron. Eng.), Trans. Antennas Propagation
*IEEE (Institute of Electrical and Electronics Engineers), Transactions on Antennas and Propagation (formerly IRE (Institute of Radio Engineers), Transactions on Antennas and Propagation) *(U. S.)*

IEEE (Inst. Elec. Electron. Eng.), Trans. Audio
*IEEE (Institute of Electrical and Electronics Engineers), Transactions on Audio *(U.S.)*

IEEE (Inst. Elec. Electron. Eng.), Trans. Automat. Contr.
*IEEE (Institute of Electrical and Electronics Engineers), Transactions on Automatic Control *(U.S.)*

IEEE (Inst. Elec. Electron. Eng.), Trans. Bio-Med. Eng.
*IEEE (Institute of Electrical and Electronics Engineers) Transactions on Bio-Medical Engineering *(U.S.)*

IEEE (Inst. Elec. Electron. Eng.), Trans. Broadcast.
*IEEE (Institute of Electric and Electronic Engineers) Transactions on Broadcasting *(U.S.)*

IEEE (Inst. Elec. Electron. Eng.), Trans. Broadcast Telev. Receivers
*IEEE (Institute of Electrical and Electronics Engineers), Transactions on Broadcast and Television Receivers *(U. S.)*

IEEE (Inst. Elec. Electron. Eng.), Trans. Circuit Theory
*IEEE (Institute of Electric and Electronic Engineers), Transactions on Circuit Theory *(U.S.)*

IEEE (Inst. Elec. Electron. Eng.), Trans. Commun. Technol.
*IEEE (Institute of Electrical and Electronics Engineers), Transactions on Communication Technology (formerly IEEE (Institute of Electrical and Electronics Engineers), Transactions on Communication and Electronics) *(U. S.)*

IEEE (Inst. Elec. Electron. Eng.), Trans. Educ.
*IEEE (Institute of Electrical and Electronics Engineers), Transactions on Education *(U. S.)*

IEEE (Inst. Elec. Electron. Eng.), Trans. Elec. Insulation
*IEEE (Institute of Electric and Electronics Engineers), Transactions on Electrical Insulation *(U.S.)*

IEEE (Inst. Elec. Electron. Eng.), Trans. Electro-Magnet. Compatibility
*IEEE (Institute of Electrical and Electronic Engineers), Transactions on Electro-Magnetic Compatibility *(U.S.)*

IEEE (Inst. Elec. Electron. Eng.), Trans. Electron. Comput.
*IEEE (Institute of Electrical and Electronic Engineers), Transactions on Electronic Computers *(U. S.)*

IEEE (Inst. Elec. Electron. Eng.), Trans. Electron Devices
*IEEE (Institute of Electric and Electronic Engineers), Transactions on Electron Devices *(U.S.)*

IEEE (Inst. Elec. Electron. Eng.), Trans. Eng. Manage.
*IEEE (Institute of Electric and Electronic Engineers), Transactions on Engineering Management *(U.S.)*

IEEE (Inst. Elec. Electron. Eng.), Trans. Eng. Writing Speech
*IEEE (Institute of Electric and Electronic Engineers), Transactions on Engineering Writing and Speech *(U.S.)*

IEEE (Inst. Elec. Electron. Eng.), Trans. Geosci. Electron.
*IEEE (Institute of Electric and Electronic Engineers), Transactions on Geoscience Electronics *(U.S.)*

IEEE (Inst. Elec. Electron. Eng.), Trans. Hum. Factors Electron.
*IEEE (Institute of Electric and Electronic Engineers), Transactions on Human Factors in Electronics *(U.S.)*

IEEE (Inst. Elec. Electron. Eng.), Trans. Ind. Electron. Contr. Instrum.
*IEEE (Institute of Electrical and Electronics Engineers), Transactions on Industrial Electronics and Control Instrumentation (formerly IEEE (Institute of Electrical and Electronics Engineers), Transactions on Industrial Electronics) *(U. S.)*

IEEE (Inst. Elec. Electron. Eng.), Trans. Ind. Gen. Appl.
*IEEE (Institute of Electric and Electronic Engineers), Transactions on Industry and General Applications *(U.S.)*

IEEE (Inst. Elec. Electron. Eng.), Trans. Inform. Theory
*IEEE (Institute of Electric and Electronic Engineers), Transactions on Information Theory *(U.S.)*

IEEE (Inst. Elec. Electron. Eng.), Trans. Instr. Meas.
*IEEE (Institute of Electrical and Electronics Engineers), Transactions on Instrumentation and Measurement (formerly IRE (Institute of Radio Engineers), Transactions on Instrumentation) *(U. S.)*

IEEE (Inst. Elec. Electron. Eng.), Trans. Magnet.
*IEEE (Institute of Electric and Electronic Engineers), Transactions on Magnetics *(U.S.)*

IEEE (Inst. Elec. Electron. Eng.), Trans. Microwave Theory Tech.
*IEEE (Institute of Electric and Electronic Engineers), Transactions on Microwave Theory and Techniques *(U. S.)*

IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.
*IEEE (Institute of Electrical and Electronics Engineers), Transactions on Nuclear Science (formerly IRE (Institute of Radio Engineers), Transactions on Nuclear Science) *(U. S.)*

IEEE (Inst. Elec. Electron. Eng.), Trans. Parts, Mater. Packaging
*IEEE (Institute of Electrical and Electronics Engineers), Transactions on Parts, Materials and Packaging (formed by a merger of IEEE (Institute of Electrical and Electronics Engineers), Transactions on Components Parts, and IEEE (Institute of Electrical and Electronics Engineers), Transactions on Products Engineering and Production) *(U. S.)*

IEEE (Inst. Elec. Electron. Eng.), Trans. Power App. Syst.
*IEEE (Institute of Electric and Electronic Engineers), Transactions on Power Apparatus and Systems *(U.S.)*

IEEE (Inst. Elec. Electron. Eng.), Trans. Rel.
*IEEE (Institute of Electric and Electronic Engineers), Transactions on Reliability *(U.S.)*

IEEE (Inst. Elec. Electron. Eng.), Trans. Sonics Ultrasonics
*IEEE (Institute of Electric and Electronic Engineers), Transactions on Sonics and Ultrasonics *(U.S.)*

IEEE (Inst. Elec. Electron. Eng.), Trans. Vehicular Commun.
*IEEE (Institute of Electric and Electronic Engineers), Transactions on Vehicular Communication *(U.S.)*

Igaku Kenkyu
Igaku Kenkyu (Acta Medica) *(Japan)*

Igaku To Seibutsugaku
Igaku To Seibutsugaku (Medicine and Biology) *(Japan)*

Igiena (Bucharest)
Igiena (Bucharest) *(Romania)*

Ikushugaku Zasshi
Ikushugaku Zasshi (Japanese Journal of Breeding) *(Japan)*

Ill. J. Math.
*Illinois Journal of Mathematics *(U.S.)*

Ill. Med. J.
Illinois Medical Journal *(U. S.)*

Immunochemistry
*Immunochemistry *(England)*

Immunology
*Immunology *(England)*

Imono
*Imono (Journal of the Japan Foundryman's Society) *(Japan)*

Ind. Aliment.
Industria Alimentara *(Romania)*

Ind. At.
*Industries Atomiques *(France)*

Ind. Chim. Belge
*Industrie Chimique Belge *(Belgium)*

Ind. Diamond Rev.
Industrial Diamond Review *(England)*

Ind. Electron.
*Industrial Electronics *(England)*

Ind. Eng. Chem.
*Industrial and Engineering Chemistry *(U. S.)*

Ind. Eng. Chem., Fundament.
*Industrial & Engineering Chemistry, Fundamentals *(U. S.)*

Ind. Eng. Chem., Process Design Develop.
*Industrial & Engineering Chemistry, Process Design and Development *(U. S.)*

Ind. Eng. Chem., Prod. Res. Develop.
*Industrial & Engineering Chemistry, Product Research and Development *(U. S.)*

Ind. Health (Kawasaki, Jap.)
*Industrial Health (Kawasaki, Japan) *(Japan)*

Ind. Heat.
Industrial Heating *(U. S.)*

Ind. Hyg. Rev.
Industrial Hygiene Review *(U. S.)*

Indian Chem. Eng.
Indian Chemical Engineer *(India)*

Indian Concrete J.
Indian Concrete Journal *(India)*

Indian East. Eng.
Indian & Eastern Engineer, The (incorporating the Far Eastern Engineer and Indian & Eastern Motors) *(India)*

Indian J. Biochem.
*Indian Journal of Biochemistry *(India)*

Indian J. Cancer
Indian Journal of Cancer *(India)*

Indian J. Chem.
*Indian Journal of Chemistry *(India)*

Indian J. Child Health
Indian Journal of Child Health, The *(India)*

Indian J. Exp. Biol.
*Indian Journal of Experimental Biology *(India)*

Indian J. Genet. Plant Breed.
*Indian Journal of Genetics and Plant Breeding *(India)*

Indian J. Med. Res.
*Indian Journal of Medical Research, The *(India)*

Indian J. Med. Sci.
Indian Journal of Medical Sciences *(India)*

Indian J. Meteorol. Geophys.
Indian Journal of Meteorology and Geophysics *(India)*

Indian J. Pathol. Bacteriol.
Indian Journal of Pathology and Bacteriology *(India)*

Indian J. Pharm.
Indian Journal of Pharmacy, The *(India)*

Indian J. Phys.
*Indian Journal of Physics and Proceedings of the Indian Association for the Cultivation of Science *(India)*

Indian J. Power River Valley Develop.
Indian Journal of Power and River Valley Development *(India)*

Indian J. Pure Appl. Phys.
*Indian Journal of Pure & Applied Physics *(India)*

Indian J. Radiol.
Indian Journal of Radiology *(India)*

Indian J. Sericult.
Indian Journal of Sericulture *(India)*

Indian J. Technol.
*Indian Journal of Technology (formerly Journal of Scientific and Industrial Research (India), Section D) *(India)*

Indian J. Theor. Phys.
*Indian Journal of Theoretical Physics *(India)*

Indian Phytopathol.
Indian Phytopathology *(India)*
Indian Pract.
Indian Practioner *(India)*
Ind. Lab. (USSR) (Engl. Transl.)
Industrial Laboratory (U.S.S.R.) (English Translation of Zavodskaya Laboratoriya) *(U.S.)*
Ind. Med. Sura.
*Industrial Medicine and Surgery *(U. S.)*
Ind. Prod. Res.
Industrial Production Research
see Seisan-Kenkyu
Ind. Res.
*Industrial Research *(U. S.)*
Ind. Tek.
*Industriell Teknik *(Sweden)*
Inform. Contr.
*Information and Control *(U.S.)*
Inform. Process
Information Process
see Joho Shori
Inform. Quim. Anal. (Madrid)
Informacion de Quimica Analitica (Madrid) *(Spain)*
Infrared Phys.
*Infrared Physics, An International Research Journal *(England)*
Ing. Arch.
*Ingenieur-Archiv; o Gesellschaft fuer Angewandte Mathematik und Mechanik *(Germany)*
Ing. Bygningsv.
Ingenieur-og Bygningsvaesen *(Denmark)*
Ing. Chim. (Milan)
*Ingegneria Chimica (Milan) *(Italy)*
Ingenieur (Utrecht)
Ingenieur, De (Utrecht) *(Netherlands)*
Ing.-Forsk.
Ingenioren-Forskning (Supersedes Ingenioren) *(Denmark)*
Ing. Mecc.
Ingegneria Meccanica *(Italy)*
Ing. Nucl.
*Ingegneria Nucleare *(Italy)*
Inorg. Chem.
*Inorganic Chemistry *(U. S.)*
Inorg. Nucl. Chem. Lett.
*Inorganic and Nuclear Chemistry Letters *(England–U. S.)*
Instrum. Contr. Syst.
*Instruments and Control Systems *(U.S.)*
Instrumentation
Instrumentation
see Keiso
Instrum. Nucl. (Paris)
*Instrumentation Nucleaire (Paris). Supplement au Bulletin d'Informations Scientifiques et Techniques (Paris) *(France)*
Instrum. Pract.
*Instrument Practice *(England)*
Instrum. Rev.
Instrument Review *(England)*
Instrum. Technol.
Instrumentation Technology (formerly ISA (Instrument Society of America) Journal) *(U. S.)*
Int. Arch. Allergy Appl. Immunol.
*International Archives of Allergy and Applied Immunology *(Switzerland)*
Int. Arch. Gewerbepathol. Gewerbehyg.
Internationales Archiv fuer Gewerbepathologie und Gewerbehygiene *(West Germany)*
Int. At. Energy Agency Bull.
*International Atomic Energy Agency Bulletin *(Austria)*
Int. Dent. J.
International Dental Journal *(Netherlands)*
Int. Elektron. Rundsch.
*Internationale Elektronische Rundschau *(Germany)*
Interceram (Luebeck, Ger.)
Interceram (Luebeck, Germany) *(West Germany)*
Internist
Internist, Der *(Germany)*
Int. Geol. Rev.
International Geology Review *(U. S.)*
Int. J. Air Water Pollut.
International Journal of Air & Water Pollution (formerly International Journal of Air Pollution) *(England)*
Int. J. Appl. Radiat. Isotop.
*International Journal of Applied Radiation and Isotopes *(England)*
Int. J. Biometerol.
International Journal of Biometeorology *(Netherlands)*
Int. J. Cancer
*International Journal of Cancer *(Denmark)*
Int. J. Contr.
*International Journal of Control *(England)*
Int. J. Electron.
*International Journal of Electronics (formerly Journal of Electronics and Control) *(England)*
Int. J. Eng. Sci.
International Journal of Engineering Science *(England)*
Int. J. Fertil.
*International Journal of Fertility *(U.S.)*
Int. J. Fracture Mech.
International Journal of Fracture Mechanics *(Netherlands)*
Int. J. Heat Mass Transfer
*International Journal of Heat and Mass Transfer *(England)*
Int. J. Neuropharmacol.
*International Journal of Neuropharmacology *(England–U. S.)*
Int. J. Non-Linear Mech.
*International Journal of Non-Linear Mechanics *(England–U.S.)*
Int. J. Oceanol. Limnol.
International Journal of Oceanology and Limnology *(U. S.)*
Int. J. Powder Met.
*International Journal of Powder Metallurgy *(U. S.)*
Int. J. Quant. Chem.
*International Journal of Quantum Chemistry *(U. S.)*
Int. J. Radiat. Biol.
*International Journal of Radiation Biology and related studies in Physics, Chemistry and Medicine *(England)*
Int. J. Rock Mech. Mining Sci.
International Journal of Rock Mechanics and Mining Sciences *(U. S.–England)*
Int. Ophthalmol. Clin.
International Ophthalmology Clinics *(U. S.)*
Int. Rev. Cytol.
*International Review of Cytology *(U. S.)*
Int. Sci. Technol.
*International Science and Technology *(U. S.)*
Int. Ser. Monogr. Nucl. Energy, Div. I
*International Series of Monographs on Nuclear Energy, Division I. Economics and Law *(U. S.)*
Int. Ser. Monogr. Nucl. Energy, Div. II
*International Series of Monographs on Nuclear Energy, Division II. Nuclear Physics *(U. S.)*
Int. Ser. Monogr. Nucl. Energy, Div. III
*International Series of Monographs on Nuclear Energy, Division III. Biology *(U. S.)*
Int. Ser. Monogr. Nucl. Energy, Div. IV
*International Series of Monographs on Nuclear Energy, Division IV. Isotopes and Radiation *(U. S.)*
Int. Ser. Monogr. Nucl. Energy, Div. V
*International Series of Monographs on Nuclear Energy, Division V. Health Physics *(U. S.)*
Int. Ser. Monogr. Nucl. Energy, Div. VI
*International Series of Monographs on Nuclear Energy, Division VI. Medicine *(U. S.)*
Int. Ser. Monogr. Nucl. Energy, Div. VII
*International Series of Monographs on Nuclear Energy, Division VII. Reactor Engineering *(U. S.)*
Int. Ser. Monogr. Nucl. Energy, Div. VIII
*International Series of Monographs on Nuclear Energy, Division VIII. Materials *(U. S.)*
Int. Ser. Monogr. Nucl. Energy, Div. IX
*International Series of Monographs on Nuclear Energy, Division IX. Chemical Engineering *(U. S.)*
Int. Ser. Monogr. Nucl. Energy, Div. X
*International Series of Monographs on Nuclear Energy, Division X. Reactor Design Physics *(U. S.)*
Int. Ser. Monogr. Nucl. Energy, Div. XI
*International Series of Monographs on Nuclear Energy, Division XI. Reactor Operational Problems *(U. S.)*
Int. Ser. Monogr. Nucl. Energy, Div. XIV
*International Series of Monographs on Nuclear Energy, Division XIV. Plasma Physics and Thermonuclear Research *(U. S.)*
Int. Z. Angew. Physiol.
*Internationale Zeitschrift fuer Angewandte Physiologie *(West Germany)*
Int. Z. Vitaminforsch.

*Internationale Zeitschrift fuer Vitaminforschung *(Switzerland)*
Invest. Ophthalmol.
*Investigative Ophthalmology *(U. S.)*
Invest. Radiol.
*Investigative Radiology *(U. S.)*
Invest. Urol.
*Investigative Urology *(U. S.)*
Inzenyrske Stavby
Inzenyrske Stavby *(Czechoslovakia)*
Inzh.-Fiz. Zh.
*Inzhenerno-Fizicheskii Zhurnal (formerly Inzhenerno-Fizicheskii Zhurnal, Akademii Nauk Belorusskoi SSR) *(Belorussian S.S.R.)*
Inzh. Sb.
Inzhenernyi Sbornik *(U.S.S.R.)*
Inzh. Zh.
Inzhenernyi Zhurnal, Akademiya Nauk SSSR *(U.S.S.R.)*
Iowa State J. Sci.
Iowa State Journal of Science *(U. S.)*
Iron Age
Iron Age *(U. S.)*
Iron Steel (London)
Iron and Steel (London) *(England)*
ISA (Instrum. Soc. Amer.) J.
*ISA (Instrument Society of America) Journal *(U.S.)*
ISA (Instrum. Soc. Amer.) Trans.
*ISA (Instrument Society of America) Transactions *(U. S.)*
Ishikawajima Harima Eng. Rev.
Ishikawajima-Harima Engineering Review
see *Ishikawajima-Harima Giho*
Ishikawajima-Harima Giho
*Ishikawajima-Harima Giho (Ishikawajima-Harima Engineering Review) *(Japan)*
Iskusstv. Sputniki Zemli, Akad. Nauk SSSR
Iskusstvennye Sputniki Zemli, Akademiya Nauk SSSR *(U.S.S.R.)*
Isotopenpraxis
*Isotopenpraxis *(Germany)*
Isotop. Radiat.
Isotopes and Radiation
see *Doitai to Hoshasen*
Isotop. Radiat. Technol.
*Isotopes and Radiation Technology (A Quarterly Technical Progress Review) *(U. S.)*
Israel J. Agr. Res.
Israel Journal of Agricultural Research, The (Ktavim) *(Israel)*
Israel J. Bot.
*Israel Journal of Botany *(Israel)*
Israel J. Chem.
*Israel Journal of Chemistry (supersedes Bulletin of the Research Council of Israel, Section A: Chemistry) *(Israel)*
Israel J. Earth-Sci.
*Israel Journal of Earth-Sciences *(Israel)*
Israel J. Exp. Med.
Israel Journal of Experimental Medicine (formerly Bulletin of the Research Council of Israel, Section E) *(Israel)*
Israel J. Math.
*Israel Journal of Mathematics *(Israel)*
Israel J. Med. Sci.
*Israel Journal of Medical Sciences (formed by a merger of Israel Medical Journal and Israel Journal of Experimental Medicine) *(Israel)*
Israel J. Phys.
Israel Journal of Physics (supersedes in part Bulletin of the Research Council of Israel, Section F: Mathematics and Physics) *(Israel)*
Israel J. Technol.
*Israel Journal of Technology *(Israel)*
Israel J. Zool.
*Israel Journal of Zoology *(Israel)*
Issled. Fiz. Atmos., Akad. Nauk Est. SSR
Issledovaniya po Fizike Atmosfery, Akademiya Nauk Estonskoi SSR *(Estonian S.S.R.)*
Issled. Stalei Splavov, Akad. Nauk SSSR, Gos. Kom. Chern. Tsvet. Met. Gosplane, SSSR, Inst. Met.
Issledovaniya Stalei i Splavov, Akademiya Nauk SSSR, Gosudarstvennyi Komitet po Chernoi i Tsvetnoi Metallurgii pri Gosplane, SSSR, Institut Metallurgii im. A. A. Baikova *(U.S.S.R.)*
Issled. Zharoprochn. Splavam, Akad. Nauk SSSR, Inst. Met.
*Issledovaniya po Zharoprochnym Splavam, Akademiya Nauk SSSR, Institut Metallurgii imeni A. A. Baikova *(U.S.S.R.)*
Istanbul Tek. Univ. Bul.
*Istanbul Teknik Universitesi Bulteni *(Turkey)*
Istanbul Univ. Fen Fak. Mecm., Seri A
*Istanbul Universitesi Fen Fakultesi Mecmuasi, Seri A *(Turkey)*
Istanbul Univ. Fen Fak. Mecm., Seri B
Istanbul Universitesi Fen Fakultesi Mecmuasi, Seri B *(Turkey)*
Istanbul Univ., Fen Fak. Mecm., Seri C
*Istanbul Universitesi Fen Fakultesi Mecmuasi, Seri C *(Turkey)*
Ital. J. Biochem.
*Italian Journal of Biochemistry *(Italy)*
Izmeritel. Tekh.
*Izmeritel'nava Tekhnika' *(U.S.S.R.)*
Izv. Akad. Nauk Arm. SSR, Nauk Zemle
*Izvestiya Akademii Nauk Armyanskoi SSR, Nauk o Zemle *(Armenian S.S.R.)*
Izv. Akad. Nauk Arm. SSR, Ser. Fiz.
*Izvestiya Akademii Nauk Armyanskoi SSR, Seriya Fizika (Formerly a Part of Izvestiya Akademii Nauk Armyanskoi SSR, Seriya Fiziko-Matematicheskikh Nauk) *(Armenian S.S.R.)*
Izv. Akad. Nauk Arm. SSR, Ser. Fiz. Mat. Nauk
*Izvestiya Akademii Nauk Armyanskoi SSR, Seriya Fiziko-Matematicheskikh Nauk *(Armenian S.S.R.)*
Izv. Akad. Nauk Arm. SSR, Ser. Mat.
*Izvestiya Akademii Nauk Armyanskoi SSR, Seriya Matematika (Formerly a Part of Izvestiya Akademii Nauk Armyanskoi SSR, Seriya Fiziko-Matematicheskikh Nauk) *(Armenian S.S.R.)*
Izv. Akad. Nauk Arm. SSR, Ser. Mekh.
*Izvestiya Akademii Nauk Armyanskoi SSR, Seriya Mekhanika (Formerly a Part of Izvestiya Akademii Nauk Armyanskoi SSR, Seriya Fiziko-Matematicheskikh Nauk) *(Armenian S.S.R.)*
Izv. Akad. Nauk Azerb. SSR, Ser. Biol. Nauk
Izvestiya Akademii Nauk Azerbaidzhanskoi SSR, Seriya Biologicheskikh Nauk *(Azerbaidzhan S.S.R.)*
Izv. Akad. Nauk Azerb. SSR, Ser. Fiz.-Tekh. Mat. Nauk
*Izvestiya Akademii Nauk Azerbaidzhanskoi SSR, Seriya Fiziko-Tekhnicheskikh i Matematicheskikh Nauk (formerly Izvestiya Akademii Nauk Azerbaidzhanskoi SSR, Seriya Fiziko-Matematicheskikh i Tekhnicheskikh Nauk) *(Azerbaidzhan S.S.R.)*
Izv. Akad. Nauk Est. SSR, Fiz. Mat.
*Izvestiya Akademii Nauk Estonskoi SSR, Fizika Matematika (formerly a part of Izvestiya Akademii Nauk Estonskoi SSR, Seriya Fiziko-Matematicheskikh i Tekhnicheskikh Nauk *(Estonian S.S.R.)*
Izv. Akad. Nauk Est. SSR, Khim. Geol.
*Izvestiya Akademii Nauk Estonskoi SSR, Khimiya Geologiya (formerly a part of Izvestiya Akademii Nauk Estonskoi SSR, Seriya Fiziko-Matematicheskikh i Tekhnicheskikh Nauk) *(Estonian S.S.R.)*
Izv. Akad. Nauk Est. SSR, Ser. Biol.
*Izvestiya Akademii Nauk Estonskoi SSR, Seriya Biologicheskaya *(Estonian S.S.R.)*
Izv. Akad. Nauk Est. SSR, Ser. Fiz. Mat. Tekh. Nauk
*Izvestiya Akademii Nauk Estonskoi SSR, Seriya Fiziko-Matematicheskikh i Tekhnicheskikh Nauk (formerly Izvestiya Akademii Nauk Estonskoi SSR, Seriya Tekhnicheskikh i Fiziko Matematicheskikh Nauk) *(Estonian S.S.R.)*
Izv. Akad. Nauk Kaz. SSR, Ser. Biol. Nauk
Izvestiya Akademii Nauk Kazakhskoi SSR, Seriya Biologicheskikh Nauk *(Kazakh S.S.R.)*
Izv. Akad. Nauk Kaz. SSR, Ser. Fiz.-Mat. Nauk
*Izvestiya Akademii Nauk Kazakhskoi SSR, Seriya Fiziko-Matematicheskikh Nauk *(Kazakh S.S.R.)*
Izv. Akad. Nauk SSSR, Energ. Transp.
*Izvestiya Akademii Nauk SSSR, Energetika i Transport (formerly Izvestiya Akademii Nauk SSSR, Otdelenie Tekhnicheskikh Nauk, Energetika i Transport) *(U.S.S.R.)*
Izv. Akad. Nauk SSSR, Fiz. Atmos. Okeana
*Izvestiya Akademii Nauk SSSR, Fizika Atmosfery i Okeana (supersedes in part Izvestiya Akademii Nauk SSSR, Seriya Geofizicheskiya) *(U.S.S.R.)*
Izv. Akad. Nauk SSSR, Fiz. Zemli
*Izvestiya Akademii Nauk SSSR, Fizika Zemli (supersedes in part Izvestiya Akademii Nauk SSSR, Seriya Geofizicheskiya) *(U.S.S.R.)*
Izv. Akad. Nauk SSSR, Mekh.
*Izvestiya Akademii Nauk SSSR, Mekhanika (formerly Izvestiya Akademii Nauk SSSR, Mekhanika i Mashino-

stroenie) *(U.S.S.R.)*

Izv. Akad. Nauk SSSR, Mekh. Zhidkosti Gaza
*Izvestiya Akademii Nauk SSSR, Mekhanika Zhidkosti i Gaza *(U.S.S.R.)*

Izv. Akad. Nauk SSSR, Metal.
*Izvestiva Akademii Nauk SSSR, Metally (formerly Izvestiva Akademii Nauk SSSR, Metalluraiva i Gornoe Delo) *(U.S.S.R.)*

Izv. Akad. Nauk SSSR, Neorg. Mater.
*Izvestiya Akademii Nauk SSSR, Neorganicheskie Materialy *(U.S.S.R.)*

Izv. Akad. Nauk SSSR, Otd. Tekh. Nauk, Met. Topl.
Izvestiya Akademii Nauk SSSR, Otdelenie Tekhnicheskikh Nauk, Metallurgiya i Toplivo *(U.S.S.R.)*

Izv. Akad. Nauk SSSR, Ser. Biol.
*Izvestiva Akademii Nauk SSSR, Seriya Bioloaicheskaya *(U.S.S.R.)*

Izv. Akad. Nauk SSSR, Ser. Fiz.
*Izvestiya Akademii Nauk SSSR, Seriya Fizicheskaya† *(U.S.S.R.)*

Izv. Akad. Nauk SSSR, Ser. Khim.
*Izvestiya Akademii Nauk SSSR, Seriya Khimicheskaya (formerly Izvestiya Akademii Nauk SSSR, Otdelenie Khimicheskikh Nauk) *(U.S.S.R.)*

Izv. Akad. Nauk Uz. SSR, Ser. Fiz.-Mat. Nauk
*Izvestiya Akademii Nauk Uzbekskoi SSR, Seriya Fiziko-Matematicheskikh Nauk *(Uzbek S.S.R.)*

Izv. Fiz. Inst. Aneb, Bulg. Akad. Nauk.
*Izvestiya na Fizicheskiya Institut s Aneb, Bulgarska Akademiya na Naukite *(Bulgaria)*

Izv. Geofiz. Inst., Bulg. Akad. Nauk.
Izvestiya na Geofizichniya Institut, Bulgarska Akademiya na Naukite, Otdelenie za Matematicheski i Fizicheski Nauki *(Bulgaria)*

Izv. Krym. Astrofiz. Observ.
*Izvestiya Krymskoi Astrofizicheskoi Observatorii *(U.S.S.R.)*

Izv. Sib. Otd. Akad. Nauk SSSR
*Izvestiya Sibirskoao Otdeleniya Akademii Nauk SSSR *(U.S.S.R.)*

Izv. Sib. Otd. Akad. Nauk SSSR, Ser. Biol.-Med. Nauk
*Izvestiya Sibirskoao Otdeleniya Akademii Nauk SSSR, Seriya Bioloao-Meditsinskikh Nauk *(U.S.S.R.)*

Izv. Sib. Otd. Akad. Nauk SSSR, Ser. Khim. Nauk
*Izvestiya Sibirskoao Otdeleniya Akademii Nauk SSSR, Seriya Khimicheskikh Nauk *(U.S.S.R.)*

Izv. Sib. Otd. Akad. Nauk SSSR, Ser. Tekh. Nauk
*Izvestiya Sibirskoao Otdeleniya Akademii Nauk SSSR, Seriya Tekhnicheskikh Nauk (supersedes in part Izvestiya Sibirskoao Otdeleniya Akademii Nauk SSSR) *(U.S.S.R.)*

Izv. Tomsk. Politekh. Inst.
Izvestiya Tomskoao Politekhnicheskoao Instituta imeni S. M. Kirova *(U.S.S.R.)*

Izv. Vyssh. Uchob. Zaved., Aviats. Tekh.
*Izvestiya Vysshikh Uchebnykh Zavedenii, Aviatsionnaya Tekhnika *(U.S.S.R.)*

Izv. Vyssh. Uchob. Zaved., Chern. Met.
Izvestiya Vysshikh Uchebnykh Zavedenii, Chernaya Metallurgiya *(U.S.S.R.)*

Izv. Vyssh. Uchob. Zaved., Energ.
Izvestiya Vysshikh Uchebnykh Zavedenii, Energetika *(U.S.S.R.)*

Izv. Vyssh. Uchob. Zaved., Fiz.
*Izvestiva Vysshikh Uchebnykh Zavedenii, Fizika *(U.S.S.R.)*

Izv. Vyssh. Uchob. Zaved., Geol. Razved.
Izvestiya Vysshikh Uchebnykh Zavedenii, Geologiya i Razvedka *(U.S.S.R.)*

Izv. Vyssh. Uchob. Zaved., Khim. Khim. Tekhnol.
*Izvestiya Vysshikh Uchebnykh Zavedenii, Khimiya i Khimicheskaya Tekhnologiya *(U.S.S.R.)*

Izv. Vyssh. Uchob. Zaved., Mashinostr.
Izvestiya Vysshikh Uchebnykh Zavedenii, Mashinostroenie *(U.S.S.R.)*

Izv. Vyssh. Uchob. Zaved., Mat.
*Izvestiya Vysshikh Uchebnykh Zavedenii, Matematika *(U.S.S.R.)*

Izv. Vyssh. Uchob. Zaved., Pishch. Tekhnol.
Izvestiya Vysshikh Uchebnykh Zavedenii, Pishchevaya Tekhnologiya *(U.S.S.R.)*

Izv. Vyssh. Uchob. Zaved., Radiofiz.
*Izvestiya Vysshikh Uchebnykh Zavednii, Radiofizika† *(U.S.S.R.)*

Izv. Vyssh. Uchob. Zaved., Tsvetn. Met.
*Izvestiya Vysshikh Uchebnykh Zavednii, Tsvetnaya Metallurgiya *(U.S.S.R.)*

Jaarb. Kankeronderz. Kankerbestrijding Ned.
Jaarboek van Kankeronderzoek en Kankerbestrijding in Nederland *(Netherlands)*

J. Acoust. Soc. Amer.
*Journal of the Acoustical Society of America *(U.S.)*

Jad. Energ.
*Jaderna Energie *(Czechoslovakia)*

J. Aeronaut. Soc. India
Journal of the Aeronautical Society of India *(India)*

J. Agr. Chem. Soc. Jap.
Journal of the Agricultural Chemical Society of Japan
see Nippon Nogeikagaku Kaishi

J. Agr. Food Chem.
*Journal of Agricultural and Food Chemistry *(U. S.)*

J. Agr. Sci.
*Journal of Agricultural Science, The *(England)*

J. Agr. Univ. Puerto Rico
Journal of Agriculture of the University of Puerto Rico, The *(Puerto Rico)*

Jahresber. Deut. Wetterdienstes
Jahresberichte des Deutschen Wetterdienstes *(Germany)*

J. Aircraft
Journal of Aircraft *(U. S.)*

J. Air Pollut. Contr. Ass.
Journal of the Air Pollution Control Association *(U. S.)*

J. Allergy
*Journal of Allergy, The *(U.S.)*

J. Amer. Ceram. Soc.
*Journal of the American Ceramic Society *(U. S.)*

J. Amer. Chem. Soc.
*Journal of the American Chemical Society *(U. S.)*

J. Amer. Dent. Ass.
*Journal of the American Dental Association, The *(U. S.)*

J. Amer. Diet. Ass.
*Journal of the American Dietetic Association *(U.S.)*

J. Amer. Geriat. Soc.
*Journal of the American Geriatrics Society *(U.S.)*

J. Amer. Med. Ass.
*Journal of the American Medical Association, The *(U. S.)*

J. Amer. Oil Chem. Soc.
*Journal of the American Oil Chemists' Society, The *(U. S.)*

J. Amer. Osteopath. Ass.
Journal of the American Osteopathic Association, The *(U. S.)*

J. Amer. Pharm. Ass.
*Journal of the American Pharmaceutical Association *(U. S.)*

J. Amer. Soc. Sugar Beet Technol.
Journal of the American Society of Sugar Beet Technologists *(U. S.)*

J. Amer. Statist. Ass.
*Journal of the American Statistical Association *(U.S.)*

J. Amer. Vet. Med. Ass.
*Journal of the American Veterinary Medical Association *(U. S.)*

J. Amer. Water Works Ass.
*Journal of the American Water Works Association *(U. S.)*

J. Anat.
*Journal of Anatomy *(England)*

J. Anim. Sci.
*Journal of Animal Science *(U. S.)*

J. Antibiot. (Tokyo), Ser. A
*Journal of Antibiotics (Tokyo), Series A *(Japan)*

Jap. Anal.
Japan Analyst
see Bunseki Kagaku

Jap. Arch. Intern. Med.
Japanese Archives of Internal Medicine
see Naika Hokan

Jap. Cir. J. (Engl. Ed.)
*Japanese Circulation Journal (English Edition) *(Japan)*

Jap. Heart J.
*Japanese Heart Journal *(Japan)*

Jap. J. Appl. Entomol. Zool.
Japanese Journal of Applied Entomology and Zoology
see Nippon Oyo Dobutsu Konchugaku Zasshi

Jap. J. Appl. Phys.
*Japanese Journal of Applied Physics *(Japan)*

Jap. J. Bacteriol.
Japanese Journal of Bacteriology
see Nippon Saikingaku Zasshi

Jap. J. Breed.
Japanese Journal of Breeding
see Ikushugaku Zasshi

Jap. J. Cancer Clin.
Japanese Journal of Cancer Clinics

see Gan no Rinsho
Jap. J. Chest Dis.
The Japanese Journal of Chest Diseases
see Nippon Kyobu Rinsho
Jap. J. Clin. Pathol.
Japanese Journal of Clinical Pathology
see Rinsho Byori
Jap. J. Exp. Med.
*Japanese Journal of Experimental Medicine *(Japan)*
Jap. J. Gastroenterol.
Japanese Journal of Gastroenterology, The
see Nippon Shokakibyo Gakkai Zasshi
Jap. J. Genet.
Japanese Journal of Genetics
see Idengaku Zasshi
Jap. J. Hyg.
Japanese Journal of Hygiene
see Nippon Eiseigaku Zasshi
Jap. J. Ind. Health
Japanese Journal of Industrial Health
see Sangyo Igaku
Jap. J. Med. Sci. Biol.
*Japanese Journal of Medical Science & Biology *(Japan)*
Jap. J. Microbiol.
*Japanese Journal of Microbiology *(Japan)*
Jap. J. Pharmacol.
*Japanese Journal of Pharmacology, The *(Japan)*
Jap. J. Public Health
Japanese Journal of Public Health
see Nippon Koshu Eisei Zasshi
Jap. J. Tuberc.
Japanese Journal of Tuberculosis, The *(Japan)*
Jap. J. Vet. Res.
*Japanese Journal of Veterinary Research *(Japan)*
Jap. J. Vet. Sci.
Japanese Journal of Veterinary Science
see Nippon Juigaku Zasshi
Jap. J. Zool.
Japanese Journal of Zoology *(Japan)*
Jap. Med. J
Japanese Medical Journal
see Nippon Iji Shimpo
Jap. Nucl. Med.
Japanese Nuclear Medicine *(Japan)*
J. Appl. Bacteriol.
*Journal of Applied Bacteriology, The *(England)*
J. Appl. Chem. (London)
*Journal of Applied Chemistry (London) *(England)*
J. Appl. Mech.
*Journal of Applied Mechanics, Transactions of the ASME, Series E *(U. S.)*
J. Appl. Meteorol.
*Journal of Applied Meteorology *(U. S.)*
J. Appl. Phys.
*Journal of Applied Physics *(U. S.)*
J. Appl. Physiol.
*Journal of Applied Physiology *(U. S.)*
J. Appl. Polymer Sci.
*Journal of Applied Polymer Science *(U. S.)*
J. Appl. Probab.
Journal of Applied Probability *(U. S.)*
Jap. Sci. Mon.
Japanese Scientific Monthly
see Gakujutsu Geppo
Jap. Steel Works Tech. Rev.
Japan Steel Works Technical Review
see Nippon Seiko Giho
J. Arkansas Med. Soc.
Journal of the Arkansas Medical Society, The *(U. S.)*
J. Ass. Offic. Agr. Chem.
*Journal of the Association of Official Agricultural Chemists *(U. S.)*
J. Ass. Offic. Anal. Chem.
*Journal of the Association of Official Analytical Chemists (Formerly Journal of the Association of Official Agricultural Chemists) *(U.S.)*
J. Ass. Physicians India
Journal of the Association of the Physicians of India *(India)*
J. Astronaut. Sci.
*Journal of the Astronautical Sciences *(U.S.)*
J. At. Energy Soc. Jap.
Journal of the Atomic Energy Society of Japan
see Nippon Genshiryoku Gakkaishi
J. Atheroscler. Res.
*Journal of Atherosclerosis Research *(Netherlands)*
J. Atmos. Sci.
*Journal of the Atmospheric Sciences (formerly the Journal of Meteorology) *(U. S.)*
J. Atmos. Terrest. Phys.
*Journal of Atmospheric and Terrestrial Physics *(U. S.)*
J. Audio Eng. Soc.
*Journal of the Audio Engineering Society *(U.S.)*
J. Aud. Res.
Journal of Auditory Research *(U. S.)*
J. Aust. Inst. Agr. Sci.
Journal of the Australian Institute of Agricultural Science, The *(Australia)*
J. Aust. Inst. Metals
Journal of the Australian Institute of Metals *(Australia)*
J. Bacteriol.
*Journal of Bacteriology *(U. S.)*
J. Basic Eng.
*Journal of Basic Engineering, Transactions of the ASME, Series D *(U. S.)*
J. Belge Radiol.
*Journal Belge de Radiologie *(Belgium)*
J. Biochem. (Tokyo)
*Journal of Biochemistry, The (Tokyo) *(Japan)*
J. Biol. Chem.
*Journal of Biological Chemistry, The *(U. S.)*
J. Biophys. Soc. Jap.
Journal of the Biophysical Society of Japan
see Seibutsu Butsuri
J. Bone Joint Surg.
*Journal of Bone and Joint Surgery, The *(U. S.)*
J. Brasil. Neurol.
Journal Brasileiro de Neurologia *(Brazil)*
J. Brasil. Psiquiat.
Journal Brasileiro de Psiquiatria *(Brazil)*
J. Brit. Interplanet. Soc.
*Journal of the British Interplanetary Society *(England)*
J. Brit. Nucl. Energy Soc.
*Journal of the British Nuclear Energy Society, The (formerly Journal of the British Nuclear Energy Conference) *(England)*
J. Brit. Waterworks Ass.
Journal of the British Waterworks Association, The *(England)*
J. Calif. State Dent. Ass.
Journal of the California State Dental Association, The *(U. S.)*
J. Can. Ass. Radiol.
*Journal of the Canadian Association of Radiologists *(Canada)*
J. Can. Ceram. Soc.
*Journal of the Canadian Ceramic Society *(Canada)*
J. Can. Dent. Ass.
Journal of the Canadian Dental Association, The *(Canada)*
J. Cardiovasc. Surg.
*Journal of Cardiovascular Surgery *(Italy)*
J. Catalysis
Journal of Catalysis *(U. S.)*
J. Cell Biol.
*Journal of Cell Biology, The (formerly Journal of Biophysical and Biochemical Cytology) *(U. S.)*
J. Cell. Comp. Physiol.
Journal of Cellular and Comparative Physiology *(U. S.)*
J. Cell. Physiol.
*Journal of Cellular Physiology (Formerly Journal of Cellular and Comparative Physiology) *(U.S.)*
J. Ceram. Ass. Jap.
Journal of the Ceramic Association of Japan
see Yogyo Kyokai Shi
J. Chem. Educ.
*Journal of Chemical Education *(U. S.)*
J. Chem. Eng. Data
*Journal of Chemical and Engineering Data *(U. S.)*
J. Chem. Phys.
*Journal of Chemical Physics, The *(U. S.)*
J. Chem. Soc.
Journal of the Chemical Society (London) *(England)*
J. Chem. Soc. (London), A.
*Journal of the Chemical Society (London), A. Inorganic Physical Theoretical (Formerly a Part of the Journal of the Chemical Society (London) *(England)*
J. Chem. Soc. (London), B.
*Journal of the Chemical Society (London), B. Physical Organic (Formerly a Part of the Journal of the Chemical Society

(London) *(England)*

J. Chem. Soc. (London), C.
*Journal of the Chemical Society (London), C. Organic (Formerly a Part of the Journal of the Chemical Society (London) *(England)*

J. Chem. Soc. Jap.
Journal of the Chemical Society of Japan
see *Nippon Kagaku Zasshi*

J. Chem. Soc. Jap., Pure Chem. Sect.
Journal of the Chemistry Society of Japan, Pure Chemistry Section
see *Nippon Kagaku Zasshi*

J. Chem. UAR
*Journal of Chemistry of the UAR *(Egypt)*

J. Child Psychol. Psychiat.
*Journal of Child Psychology and Psychiatry and Allied Disciplines *(England)*

J. Chim. Phys.
*Journal de Chimie Physique et de Physicochimie Biologique *(France)*

J. Chin. Chem. Soc. (Taiwan)
*Journal of the Chinese Chemical Society (Taiwan) *(China)*

J. Chromatog.
*Journal of Chromatography *(Netherlands)*

J. Chron. Dis.
*Journal of Chronic Diseases *(U.S.)*

J. Clin. Endocrinol. Metab.
*Journal of Clinical Endocrinology and Metabolism, The *(U. S.)*

J. Clin. Invest.
*Journal of Clinical Investigation, The *(U. S.)*

J. Clin. Pathol.
*Journal of Clinical Pathology *(England)*

J. Clin. Psychol.
Journal of Clinical Psychology *(U. S.)*

J. Colloid Interface Sci.
*Journal of Colloid and Interface Science (formerly Journal of Colloid Science) *(U. S.)*

J. Colloid Sci.
Journal of Colloid Science *(U.S.)*

J. Coll. Radiol. Australas.
Journal of the College of Radiologists of Australasia *(Australia)*

J. Comp. Neurol.
*Journal of Comparative Neurology, The *(U.S.)*

J. Compos. Mater.
*Journal of Composite Materials *(U. S.)*

J. Comp. Pathol.
*Journal of Comparative Pathology (formerly Journal of Comparative Pathology and Therapeutics) *(England)*

J. Comp. Pathol. Ther.
Journal of Comparative Pathology and Therapeutics, The *(England)*

J. Comp. Physiol. Psychol.
*Journal of Comparative and Physiological Psychology *(U.S.)*

J. Comput. Phys.
Journal of Computational Physics *(U. S.)*

J. Constr. Div., Amer. Soc. Civil Eng.
Journal of the Construction Division, Proceedings of the American Society of Civil Engineers *(U. S.)*

J. Dairy Res.
*Journal of Dairy Research, The *(England)*

J. Dairy Sci.
*Journal of Dairy Science *(U. S.)*

J. Dent. Children
Journal of Dentistry for Children *(U. S.)*

J. Dent. Res.
*Journal of Dental Research, The *(U. S.)*

J. Econ. Entomol.
*Journal of Economic Entomology *(U. S.)*

J. Egypt. Med. Ass.
Journal of the Egyptian Medical Association, The *(Egypt)*

J. Electroanal. Chem.
Journal of Electroanalytical Chemistry *(Netherlands)*

J. Electroanal. Chem. Interfacial Electrochem.
*Journal of Electroanalytical Chemistry and Interfacial Electrochemistry (formerly Journal of Electroanalytical Chemistry) *(Netherlands)*

J. Electrochem. Soc.
*Journal of the Electrochemical Society *(U. S.)*

J. Electron. Contr.
Journal of Electronics and Control *(England)*

J. Electronmicroscopy (Tokyo)
*Journal of Electromicroscopy (Tokyo) *(Japan)*

J. Embryol. Exp. Morphol.
*Journal of Embryology and Experimental Morphology *(England)*

Jena Rev.
Jena Review *(East Germany)*

J. Endocrinol.
*Journal of Endocrinology, The *(England)*

J. Eng. Educ.
Journal of Engineering Education *(U. S.)*

J. Eng. Ind.
*Journal of Engineering for Industry, Transactions of the ASME, Series B *(U. S.)*

J. Eng. Power
*Journal of Engineering for Power, Transactions of the ASME, Series A *(U. S.)*

J. Environ. Sci.
Journal of Environmental Sciences *(U. S.)*

Jernkontorets Ann.
*Jernkontorets Annaler *(Sweden)*

JETP Lett. (USSR) (Engl. Transl.)
*JETP Letters (USSR) (English Translation of Zhurnal Eksperimental'noi i Teoreticheskoi Fiziki, Pis'ma v Redaktsiyu) *(U. S.)*

J. Exp. Anal. Behav.
*Journal of Experimental Analysis of Behavior *(U.S.)*

J. Exp. Biol.
*Journal of Experimental Biology, The *(England)*

J. Exp. Bot.
*Journal of Experimental Botany *(England)*

J. Exp. Med.
*Journal of Experimental Medicine *(U. S.)*

J. Exp. Psychol.
*Journal of Experimental Psychology *(U.S.)*

J. Exp. Zool.
*Journal of Experimental Zoology *(U. S.)*

J. Fac. Agr., Kyushu Univ.
Journal of the Faculty of Agriculture, Kyushu University *(Japan)*

J. Fac. Eng., Univ. Tokyo
*Journal of the Faculty of Engineering, University of Tokyo *(Japan)*

J. Fac. Sci. Univ. Tokyo, Sect. 1
*Journal of the Faculty of Science, University of Tokyo, Section I *(Japan)*

J. Ferment. Ass. Jap.
Journal of the Fermentation Association of Japan
see *Hakko Kyokaishi*

J. Ferment. Technol.
Journal of Fermentation Technology
see *Hakko Kogaku Zasshi*

J. Fish. Res. Board Can.
Journal of the Fisheries Research Board of Canada *(Canada)*

J. Fluid Mech.
*Journal of Fluid Mechanics *(England–U. S.)*

J. Food Sci.
*Journal of Food Science (formerly Food Research) *(U. S.)*

J. Forensic Sci.
Journal of Forensic Sciences *(U. S.)*

J. Forensic Sci. Soc.
Journal of the Forensic Science Society *(England)*

J. Franklin Inst.
*Journal of the Franklin Institute *(U. S.)*

J. Fr. Med. Chir. Thorac.
Journal Francais de Medecine et Chirurgie Thoracique *(France)*

J. Fuel Soc. Jap.
Journal of the Fuel Society of Japan
see *Nenryo Kyokai-Shi*

J. Gas Chromatogr.
*Journal of Gas Chromatography *(U.S.)*

J. Gen. Appl. Microbiol. (Tokyo)
*Journal of General and Applied Microbiology (Tokyo) *(Japan)*

J. Genet.
*Journal of Genetics *(U. S.)*

J. Genet. Hum.
*Journal de Genetique Humaine *(Switzerland)*

J. Genet. Psychol.
*Journal of Genetic Psychology, The *(U. S.)*

J. Gen. Microbiol.
*Journal of General Microbiology *(England)*

J. Gen. Physiol.
*Journal of General Physiology *(U. S.)*

J. Gen. Virol.

Journal of General Virology *(England)*
J. Geol. Soc. Aust.
Journal of the Geological Society of Australia *(Australia)*
J. Geol. Soc. Jap.
Journal of the Geological Society of Japan
see Chishitsugaku Zasshi
J. Geomagnet. Geoelec.
*Journal of Geomagnetism and Geoelectricity *(Japan)*
J. Geophys. Res.
*Journal of Geophysical Research *(U. S.)*
J. Gerontol.
*Journal of Gerontology *(U. S.)*
J. Heat Transfer
*Journal of Heat Transfer, Transactions of the ASME, Series C *(U. S.)*
J. Heredity
*Journal of Heredity *(U. S.)*
J. Heterocycl. Chem.
*Journal of Heterocyclic Chemistry *(U. S.)*
J. Histochem. Cytochem.
*Journal of Histochemistry and Cytochemistry, The *(U. S.)*
J. Hydrol.
Journal of Hydrology *(Netherlands)*
J. Hyg.
*Journal of Hygiene, The *(U.S.)*
J. Hyg. Chem.
Journal of Hygienic Chemistry, The
see Eisei Kagaku
J. Hyg. Epidemiol. Microbiol. Immunol.
*Journal of Hygiene, Epidemiology, Microbiology, and Immunology *(Czechoslovakia)*
Jibi Inko-ka
Jibi Inko-ka (Otolaryngology) *(Japan)*
Jido Seigyo
*Jido Seigyo (Automatic Control) *(Japan)*
Jikeikai Med. J.
*Jikeikai Medical Journal *(Japan)*
J. Immunol.
*Journal of Immunology, The *(U. S.)*
J. Ind. Eng.
*Journal of Industrial Engineering *(U.S.)*
J. Indian Chem. Soc.
*Journal of the Indian Chemical Society *(India)*
J. Indian Inst. Sci.
*Journal of the Indian Institute of Science *(India)*
J. Indian Med. Ass.
Journal of the Indian Medical Association *(India)*
J. Infect. Dis.
*Journal of Infectious Diseases, The *(U. S.)*
J. Inorg. Nucl. Chem.
*Journal of Inorganic & Nuclear Chemistry *(England)*
J. Insect Physiol.
*Journal of Insect Physiology *(U. S.)*
J. Inst. Elec. Commun. Eng. Jap.
Journal of the Inst. of Electrical Communication Engineers of Japan, The
see Denki Tsushin Gakkai Zasshi
J. Inst. Elec. Eng. Jap.
Journal of the Institute of Electric Engineers of Japan, The
see Denki Gakkai Zasshi
J. Inst. Eng., Aust.
Journal of the Institution of Engineers, Australia *(Australia)*
J. Inst. Fuel
Journal of the Institute of Fuel *(England)*
J. Inst. Math. Appl.
*Journal of the Institute of Mathematics and Its Applications *(England)*
J. Inst. Metals
*Journal of the Institute of Metals with Bulletin and Metallurgical Abstracts *(England)*
J. Inst. Petrol.
*Journal of the Institute of Petroleum *(England)*
J. Inst. Water Eng.
Journal of the Institution of Water Engineers *(England)*
J. Int. Coll. Surg.
Journal of the International College of Surgeons, The *(U. S.)*
J. Invertebr. Pathol.
*Journal of Invertebrate Pathology *(U.S.)*
J. Invest. Dermatol.
*Journal of Investigative Dermatology, The *(U. S.)*
J. Iowa Med. Soc.
Journal of the Iowa Medical Society *(U. S.)*

J. Iron Steel Inst. (Jap.)
Journal of the Iron and Steel Institute (Japan)
see Tetsu To Hagane
J. Iron Steel Inst. (London)
*Journal of the Iron and Steel Institute (London) *(England)*
J. Jap. Ass. Automat. Contr. Eng.
Journal of the Japan Association of Automatic Control Engineers
see Seigyo Kogaku
J. Jap. Ass. Petrol. Technol.
Journal of the Japanese Association of Petroleum Technologists
see Sekiyu Gijutsu Kyokaishi
J. Jap. Boiler Ass.
Journal of the Japan Boiler Association
see Boiro Kenkyu
J. Jap. Chem.
Journal of Japanese Chemistry
see Kagaku No Ryoiki
J. Jap. Forest. Soc.
Journal of the Japanese Forestry Society
see Nippon Ringaku Kaishi
J. Jap. Foundrymen's Soc.
Journal of the Japan Foundryman's Society
see Imono
J. Jap. Inst. Metals (Sendai)
Journal of the Japan Institute of Metals (Sendai)
see Nippon Kinzoku Gakkaishi
J. Jap. Obstet. Gynecol. Soc. (Engl. Ed.)
Journal of the Japanese Obstetrical and Gynecological Society (English Edition of Nippon Sanfrejinka Zasshi) *(Japan)*
J. Jap. Oil Chem. Soc.
Journal of Japan Oil Chemists' Society
see Yukagaku
J. Jap. Soc. Aeronaut. Space Sci.
Journal of Japanese Society for Aeronautical and Space Science
see Nippon Koku Gakkaishi
J. Jap. Soc. Civil Eng.
Journal of the Japan Society of Civil Engineers
see Doboku Gakkaishi
J. Jap. Soc. Intern. Med.
Journal of Japanese Society of Internal Medicine, The
see Nippon Naika Gakka Zasshi
J. Jap. Soc. Lubric. Eng.
Journal of Japan Society of Lubrication Engineers
see Junkatsu
J. Jap. Soc. Mater.
Journal of the Japan Society for Materials
see Zairyo
J. Jap. Soc. Mech. Eng.
Journal of the Japan Society of Mechanical Engineers
see Nippon Kikai Gakkaishi
J. Jap. Soc. Powder Met.
Journal of the Japan Society of Power Metallurgy
see Funtai Oyobi Funmatsuyakin
J. Jap. Soc. Technol. Plast.
Journal of Japan Society for Technology of Plasticity
see Sosei to Koko
J. Jap. Stomatol. Soc.
Journal of the Japan Stomatological Society, The
see Kokubyogakkai Zasshi
J. Juzen Med. Soc.
Journal of the Juzen Medical Society, The
see Juzen Igakukai Zasshi
J. Kans. Med. Soc.
Journal of the Kansas Medical Society, The *(U. S.)*
J. Keio Med. Soc.
Journal of the Keio Medical Society
see Keio Igaku
J. Korean Chem. Soc.
Journal of the Korean Chemical Society
see Ta Han Hua Hsueh Hui-Chih
J. Kumamoto Med. Soc.
Journal of the Kumamoto Medical Society, The
see Kumamoto Igakkai Zasshi
J. Lab. Clin. Med.
*Journal of Laboratory and Clinical Medicine, The *(U. S.)*
J. Label. Compounds
*Journal of Labelled Compounds *(Belgium)*
J. Lancet
*Journal-Lancet, The *(U. S.)*
J. Laryngol. Otol.
Journal of Laryngology and Otology, The *(England)*
J. La. State Med. Soc.

Journal of the Louisiana State Medical Society *(U. S.)*

J. Less-Common Metals
*Journal of the Less-Common Metals *(Netherlands)*

J. Lipid Res.
*Journal of Lipid Research *(U. S.)*

J. London Math. Soc.
*Journal of the London Mathematical Society *(England)*

J. Lubric. Technol.
*Journal of Lubrication Technology, Transactions of the ASME (American Society of Mechanical Engineers), Series F *(U. S.)*

J. Mar. Biol. Ass. U.K.
*Journal of the Marine Biological Association of the United Kingdom *(England)*

J. Mater.
*Journal of Materials *(U.S.)*

J. Mater. Sci.
*Journal of Materials Science *(England)*

J. Math. Anal. Appl.
*Journal of Mathematical Analysis and Applications *(U. S.)*

J. Math. Mech.
*Journal of Mathematics and Mechanics *(U. S.)*

J. Math. Phys. (Cambridge, Mass.)
*Journal of Mathematics and Physics (Cambridge, Mass.) *(U. S.)*

J. Math. Phys. (N. Y.)
*Journal of Mathematical Physics (New York) *(U. S.)*

J. Math. Psychol.
*Journal of Mathematical Psychology *(U. S.)*

J. Math. Pures Appl.
*Journal de Mathematiques Pures et Appliquees *(France)*

J. Math. Soc. Jap.
*Journal of the Mathematical Society of Japan *(Japan)*

J. Mecan.
*Journal de Mecanique *(France)*

J. Mecan. Phys. Atmos.
Journal de Mecanique et Physique de l'Atmosphere *(France)*

J. Mech. Eng. Sci.
*Journal of Mechanical Engineering Science, The *(England)*

J. Mech. Lab. Jap.
Journal of the Mechanical Laboratory of Japan *(Japan)*

J. Mech. Phys. Solids
*Journal of the Mechanics and Physics of Solids *(England)*

J. Med. Ass. State Ala.
Journal of the Medical Association of the State of Alabama, The *(U. S.)*

J. Med. Bordeaux Sud-Ouest
Journal de Medecine de Bordeaux et du Sud-Ouest *(France)*

J. Med. Chem.
*Journal of Medicinal Chemistry *(U. S.)*

J. Med. Genet.
*Journal of Medical Genetics *(England)*

J. Med. Lab. Technol.
Journal of Medical Laboratory Technology *(England)*

J. Med. Soc. Toho Univ.
Journal of the Medical Society of Toho University
*see **Toho Igakkai Zasshi***

J. Metals
*Journal of Metals *(U. S.)*

J. Meteorol.
Journal of Meteorology, The *(U. S.)*

J. Meteorol. Res.
Journal of Meteorological Research
*see **Kisocho Kenkyu Jiho***

J. Meteorol. Soc. Jap.
Journal of the Meteorological Society of Japan *(Japan)*

J. Microscop.
*Journal de Microscopie *(France)*

J. Milk Food Technol.
*Journal of Milk and Food Technology *(U. S.)*

J. Min. Metallurgical Inst. Jap.
Journal of the Mining and Metallurgical Institute of Japan
*see **Nippon Kogyo Kaishi***

J. Mississippi State Med. Ass.
Journal of the Mississippi State Medical Association *(U. S.)*

J. Mol. Biol.
*Journal of Molecular Biology *(England)*

J. Mol. Spectrosc.
*Journal of Molecular Spectroscopy *(U. S.)*

J. Morphol.
*Journal of Morphology *(U. S.)*

J. Mount Sinai Hosp., N. Y.
Journal of the Mount Sinai Hospital, New York *(U. S.)*

J. Nagasaki Med. Ass.
Journal of the Nagasaki Medical Association
*see **Nagasaki Igakkai Zasshi***

J. Nara Gakugei Univ.
Journal of the Nara Gakugei University
*see **Nara Gakugei Daigaku Kiyo***

J. Nara Med. Ass.
Journal of the Nara Medical Association
*see **Nara Igaku Zasshi***

J. Nat. Cancer Inst.
*Journal of the National Cancer Institute *(U. S.)*

J. Nat. Med. Ass.
Journal of the National Medical Association *(U. S.)*

J. Nat. Res. Counc. Thailand
*Journal of the National Research Council of Thailand (contains Part I. Natural Science and Part II. Social Science, paged separately) *(Thailand)*

J. Natur. Sci. Math.
*Journal of Natural Sciences and Mathematics *(Pakistan)*

J. N. D. I. (Jap.)
Journal of N. D. I. (Japan)
*see **Hi-hakai Kensa***

J. Neurochem.
*Journal of Neurochemistry *(England)*

J. Neurol. Neurosurg. Psychiat.
*Journal of Neurology, Neurosurgery, and Psychiatry *(England)*

J. Neuropathol. Exp. Neurol.
*Journal of Neuropathology and Experimental Neurology, The *(U. S.)*

J. Neurophysiol.
*Journal of Neurophysiology *(U. S.)*

J. Neurosurg.
*Journal of Neurosurgery *(U. S.)*

J. Newark Beth Israel Hosp.
Journal of the Newark Beth Israel Hospital *(U. S.)*

J. New Drugs
*Journal of New Drugs, The *(U. S.)*

J. Nucl. Biol. Med.
*Journal of Nuclear Biology and Medicine (supersedes in part Minerva Nucleare) *(Italy)*

J. Nucl. Energy
*Journal of Nuclear Energy (formerly Journal of Nuclear Energy, Parts A & B, Reactor Science and Technology) *(England)*

J. Nucl. Energy: Pt. A & B
Journal of Nuclear Energy: Parts A & B, Reactor Science and Technology (formerly issued separately) *(England)*

J. Nucl. Energy: Pt. C
Journal of Nuclear Energy: Part C, Plasma Physics–Accelerators–Thermonuclear Research *(England)*

J. Nucl. Mater.
*Journal of Nuclear Materials (Journal des Materiaux Nucleaires) *(Netherlands)*

J. Nucl. Med.
*Journal of Nuclear Medicine *(U. S.)*

J. Nucl. Sci. Technol. (Tokyo)
*Journal of Nuclear Science and Technology (Tokyo) *(Japan)*

J. Nutr.
*Journal of Nutrition, The *(U. S.)*

J. N. Z. Inst. Chem.
*Journal of the New Zealand Institute of Chemistry *(New Zealand)*

J. Obstet. Gynaecol. Brit. Commonwealth
Journal of Obstetrics and Gynaecology of the British Commonwealth *(England)*

J. Occup. Med.
Journal of Occupational Medicine *(U. S.)*

J. Oceanogr. Soc. Jap.
Journal of the Oceanographical Society of Japan
*see **Nippon Kaiyo Gakkaishi***

J. Offic. Repub. Fr.
Journal Officiel de la Republique Francaise *(France)*

Joho Shori
Joho Shori (Information Process) *(Japan)*

J. Okayama Med. Soc.
Journal of Okayama Medical Society
*see **Okayama Igakkai Zasshi***

J. Okla. State Med. Ass.
Journal of the Oklahoma State Medical Association, The *(U. S.)*

J. Opt. Soc. Amer.
*Journal of the Optical Society of America *(U. S.)*

J. Oral Ther. Pharmacol.
*Journal of Oral Therapeutics and Pharmacology *(U. S.)*

J. Organometal. Chem. (Amsterdam)
*Journal of Organometallic Chemistry (Amsterdam) *(Netherlands)*
J. Org. Chem.
*Journal of Organic Chemistry, The *(U. S.)*
J. Osaka City Med. Cent.
Journal of the Osaka City Medical Center, The
see *Osaka Shiritsu Daigaku Igaku Zasshi*
J. Parasitol.
*Journal of Parasitology, The *(U. S.)*
J. Pathol. Bacteriol.
*Journal of Pathology and Bacteriology, The *(Scotland)*
J. Pediat.
*Journal of Pediatrics, The *(U. S.)*
J. Periodontol.
*Journal of Periodontology, The *(U. S.)*
J. Petrol.
Journal of Petrology *(England)*
J. Petrol. Technol.
*Journal of Petroleum Technology *(U. S.)*
J. Pharmacol. Exp. Ther.
*Journal of Pharmacology and Experimental Therapeutics, The *(U. S.)*
J. Pharm. Belg.
Journal de Pharmacie de Belgique *(Belgium)*
J. Pharm. Pharmacol.
*Journal of Pharmacy and Pharmacology *(England)*
J. Pharm. Sci.
*Journal of Pharmaceutical Sciences *(U. S.)*
J. Pharm. Soc. Jap.
Journal of the Pharmaceutical Society of Japan
see *Yakugaku Zasshi*
J. Philipp. Med. Ass.
Journal of the Philippine Medical Association *(Philippines)*
J. Photogr. Sci.
Journal of Photographic Science *(England)*
J. Phys. (Paris)
*Journal de Physique (Paris) (formerly Le Journal de Physique et le Radium) *(France)*
J. Phys. (Paris), Colloq.
*Journal de Physique (Paris), Colloque *(France)*
J. Phys. (Paris), Suppl.
*Journal de Physique, Le (Paris), Supplement *(France)*
J. Phys. Chem.
*Journal of Physical Chemistry, The *(U. S.)*
J. Phys. Chem. Solids
*Journal of Physics and Chemistry of Solids (formerly Physics and Chemistry of Solids, The) *(England–U. S.)*
J. Phys. Earth (Tokyo)
Journal of Physics of the Earth (Tokyo) *(Japan-U. S.)*
J. Physiol. (London)
*Journal of Physiology, the (London) *(England)*
J. Physiol. (Paris)
*Journal de Physiologie (Paris) *(France)*
J. Phys., Phys. Appl. (Paris)
*Journal de Physique, Physique Appliqué (Paris). Supplement au Journal de Physique (Paris) *(France)*
J. Phys. Radium
Journal de Physique et Le Radium, Le (France)
J. Phys. Soc. Jap.
*Journal of the Physical Society of Japan *(Japan)*
J. Plasma Phys., Part 1
Journal of Plasma Physics, Part 1 *(England)*
J. Polarogr. Soc.
*Journal of the Polarographic Society *(England)*
J. Polym. Sci., Part A
Journal of Polymer Science, Part A: General Papers *(U. S.)*
J. Polym. Sci., Part A–1
*Journal of Polymer Science, Part A–1: Polymer Chemistry *(U. S.)*
J. Polym. Sci., Part A–2
*Journal of Polymer Science, Part A–2: Polymer Physics *(U. S.)*
J. Polym. Sci., Part B
*Journal of Polymer Science, Part B: Polymer Letters *(U. S.)*
J. Polym. Sci., Part C
*Journal of Polymer Science, Part C: Polymer Symposia *(U. S.)*
J. Power Div., Amer. Soc. Civil Eng.
Journal of the Power Division, Proceedings of the American Society of Civil Engineers *(U. S.)*
J. Prakt. Chem.
*Journal fuer Praktische Chemie *(Germany)*
J. Prestressed Concrete Inst.
Journal of the Prestressed Concrete Institute *(U. S.)*
J. Proc. Roy. Soc. N. S. W.
Journal and Proceedings of the Royal Society of New South Wales *(Australia)*
J. Prosth. Dent.
*Journal of Prosthetic Dentistry, The *(U. S.)*
J. Protozool.
*Journal of Protozoology, The *(U. S.)*
J. Quant. Spectrosc. Radiative Transfer
*Journal of Quantitative Spectroscopy & Radiative Transfer *(England)*
J. Radiat. Res. (Jap.)
*Journal of Radiation Research *(Japan)*
J. Radiol., Electrol. Med. Nucl.
*Journal de Radiologie, d'Electrologie, et de Medicine Nucleaire *(France)*
J. Radio Res. Lab., Tokyo
*Journal of the Radio Research Laboratories, Tokyo *(Japan)*
J. Reine Angew. Math.
*Journal fuer die Reine und Angewandte Mathematik *(Germany)*
J. Reprod. Fertil.
*Journal of Reproduction and Fertility *(England)*
J. Res.
Journal of Research
see *Kenkyu Kiho*
J. Res. Inst. Catalysis, Hokkaido Univ.
*Journal of the Research Institute for Catalysis, Hokkaido University *(Japan)*
J. Res. Inst. Microbial Dis.
Journal of the Research Institute for Microbial Diseases
see *Biken Journal*
J. Res. Nat. Bur. Stand., A
*Journal of Research of the National Bureau of Standards, A *(U. S.)*
J. Res. Nat. Bur. Stand., B
*Journal of Research of the National Bureau of Standards, B *(U. S.)*
J. Res. Nat. Bur. Stand., C
*Journal of Research of the National Bureau of Standards, C *(U. S.)*
J. Res. Nat. Bur. Stand., D
Journal of Research of the National Bureau of Standards, D *(U. S.)*
J. Reticuloendothel. Soc.
Journal of the Reticuloendothelial Society
see *RES, J. Reticuloendothel. Soc.*
J. Roy. Aeronaut. Soc.
*Journal of the Royal Aeronautical Society *(England)*
J. Roy. Microscop. Soc.
Journal of the Royal Microscopical Society *(England)*
J. Roy. Statist. Soc., Ser. A
*Journal of the Royal Statistical Society, Series A, General *(England)*
J. Roy. Statist. Soc., Ser. B
*Journal of the Royal Statistical Society, Series B, Methodical *(England)*
J. S. Afr. Chem. Inst.
Journal of the South African Chemical Institute *(S. Africa)*
J. S. Afr. Inst. Mining Met.
Journal of the South African Institute of Mining and Metallurgy, The *(South Africa)*
J. Sanit. Eng. Div., Amer. Soc. Civil Eng.
Journal of the Sanitary Engineering Division, Proceedings of the American Society of Civil Engineers *(U. S.)*
J. San'yo Ass. Advance. Sci. Eng.
Journal of the San'yo Association for Advancement of Science and Engineering
see *San'yo Gijutsu Zasshi*
J. S. Calif. State Dent. Ass.
Journal of the Southern California State Dental Association *(U. S.)*
J. Sci. Eng. Res., Indian Inst. Technol., Kharagpur
Journal of Science and Engineering Research, Indian Institute of Technology, Kharagpur *(India)*
J. Sci. Food Agr.
*Journal of the Science of Food and Agriculture *(England)*
J. Sci. Hiroshima Univ. Ser. A-II
*Journal of Science of the Hiroshima University. Series A-II *(Japan)*
J. Sci. Ind. Res. (India)
*Journal of Scientific and Industrial Research *(India)*

J. Sci. Instrum.
*Journal of Scientific Instruments *(England)*
J. Sci. Labor
Journal of Science of Labor, The
see *Rodo Kagaku*
J. Sci. Med. Lille
Journal des Sciences Medicales de Lille *(France)*
J. Soc. Cosmet. Chem.
*Journal of the Society of Cosmetic Chemists (British Edition) *(England)*
J. Soc. Dairy Technol.
Journal of the Society of Dairy Technology, The *(England)*
J. Soc. High Pressure Gas Ind.
Journal of the Society of High Pressure Gas Industry
see *Koatsu Gasu Kyokaishi*
J. Soc. Ind. Appl. Math.
*Journal of the Society of Industrial and Applied Mathematics *(U. S.)*
J. Soc. Instrum. Contr. Eng.
Journal of the Society of Instrument and Control Engineers
see *Keisoku to Seigyo*
J. Soc. Org. Syn. Chem., Jap.
Journal of the Society of Organic Synthetic Chemistry, Japan
see *Yuki Gosei Kagaku Kyokai Shi*
J. Soc. Psychol.
Journal of Social Psychology *(U. S.)*
J. Soil Sci.
*Journal of Soil Science, the *(England)*
J. Sound Vib.
*Journal of Sound and Vibration *(England)*
J. Spacecraft Rockets
*Journal of Spacecraft and Rockets *(U. S.)*
J. Spectrosc. Soc. Jap.
Journal of the Spectroscopical Society of Japan
see *Bunko Kenkyu*
J. Strain Anal.
Journal of Strain Analysis *(England)*
J. Surg. Res.
*Journal of Surgical Research *(U. S.)*
J. Tech. Lab.
Journal of the Technical Laboratory
see *Gijutsu Kenkyusho Shoho*
J. Tenn. Acad. Sci.
Journal of the Tennessee Academy of Science *(U. S.)*
J. Theoret. Biol.
*Journal of Theoretical Biology *(England)*
J. Ther.
Journal of Therapy
see *Chiryo*
J. Thorac. Cardiov. Surg.
*Journal of Thoracic and Cardiovascular Surgery *(U. S.)*
J. Tohoku Mining Soc.
Journal of the Tohoku Mining Society
see *Tohoku Kozan*
J. Tokyo Med. Coll.
Journal of Tokyo Medical College, The
see *Tokyo Ika Daigaku Zasshi*
J. Trauma
*Journal of Trauma *(U. S.)*
J. Trop. Med. Hyg.
*Journal of Tropical Medicine and Hygiene, The *(England)*
J. Ultrastruct. Res.
*Journal of Ultrastructure Research *(U. S.)*
Junkatsu
*Junkatsu (Journal of Japan Society of Lubrication Engineers) *(Japan)*
J. Urol.
*Journal of Urology, The *(U. S.)*
Juzen Igakukai Zasshi
Juzen Igakukai Zasshi (The Journal of The Juzen Medical Society) *(Japan)*
J. Vac. Sci. Technol.
*Journal of Vacuum Science and Technology, The *(U. S.)*
J. Vac. Soc. Jap.
Journal of the Vacuum Society of Japan
see *Shinku*
J. Virol.
Journal of Virology *(U. S.)*
J. Vitaminol. (Kyoto)
*Journal of Vitaminology, The (Kyoto) *(Japan)*
J. Wash. Acad. Sci.
Journal of the Washington Academy of Sciences *(U. S.)*

J. Water Pollut. Contr. Fed.
Journal of the Water Pollution Control Federation (formerly Sewage and Industrial Wastes) *(U. S.)*
J. Water Waste
Journal of Water and Waste
see *Yosui to Haisui*
J. Wildlife Manage.
Journal of Wildlife Management *(U. S.)*
J. Yonago Med. Ass.
Journal of the Yonago Medical Association, The
see *Yonago Igaku Zasshi*
Kachiku Eisei Shikenjo Kenkyu Hokoku
Kachiku Eisei Shikenjo Kenkyu Hokoku (Bulletin of National Institute of Animal Health) *(Japan)*
Kaeltetech.-Klim.
Kaeltetechnik-Klimatisierung (formerly Kaeltetechnik) *(West Germany)*
Kagaku (Tokyo)
*Kagaku (Tokyo) (Science) *(Japan)*
Kagaku Kogaku
*Kagaku Kogaku (Chemical Engineering) *(Japan)*
Kagaku Kogyo
*Kagaku Kogyo (Chemical Industry) *(Japan)*
Kagaku No Ryoiki
*Kagaku No Ryoiki (Journal of Japanese Chemistry) *(Japan)*
Kagaku To Kogyo (Tokyo)
*Kagaku To Kogyo (Tokyo) (Chemistry and Chemical Industry) *(Japan)*
Kagoshima Daigaku Igaku Zasshi
Kagoshima Daigaku Igaku Zasshi (Medical Journal of Kagoshima University) *(Japan)*
Kakuyugo-Kenkyu
*Kakuyugo-Kenkyu (Nuclear Fusion Research) *(Japan)*
Kans. State Univ., Eng. Exp. Sta., Bull.
*Kansas State University, Engineering Experiment Station, Bulletin *(U. S.)*
Karyoku Hatsuden
*Karyoku Hatsuden (The Thermal Power) *(Japan)*
Kauchuk Rezina
Kauchuk i Rezina† *(U.S.S.R.)*
Keikinzoku
Keikinzoku (Light Metals (Tokyo)) *(Japan)*
Keio Igaku
Keio Igaku (Journal of the Keio Medical Society) *(Japan)*
Keio J. Med.
Keio Journal of Medicine, The *(Japan)*
Keiso
*Keiso (Instrumentation) *(Japan)*
Keisoku to Seigyo
*Keisoku To Seigyo (Journal of the Society of Instrument and Control Engineers) *(Japan)*
Kem. Teollisuus
Kemian Teollisuus *(Finland)*
Kenkyu Kiho
*Kenkyu Kiho (Journal of Research) *(Japan)*
Kernenergie
*Kernenergie *(East Germany)*
Kerntechnik
*Kerntechnik, Isotopentechnik und -Chemie *(Germany)*
KFKI (Kozp. Fiz. Kut. Intez.) Kozlemen.
*KFKI (Kozponti Fizikai Kutato Intezet) Kozlemenyek *(Hungary)*
Kgl. Dan. Vidensk. Selsk., Mat.-Fys. Medd.
*Kongelige Danske Videnskabernes Selskab, Det, Matematisk-Fysiske Meddelelser *(Denmark)*
Kgl. Dan. Vidensk. Selsk., Mat.-Fys. Skr.
*Kongelige Danske Videnskabernes Selskab, Det, Matematisk-Fysiske Skrifter *(Denmark)*
Kgl. Norske Vidensk. Selsk., Forh.
*Kongelige Norske Videnskabers Selskabs, Det, Forhandlinger *(Norway)*
Kgl. Vet.-Land-Bohoejsk., Arsskr.
Kongelige Veterinar- og Land-Bohoejskole, Arsskrift *(Denmark)*
Khim. Anal. Tsvet. Redk. Metal., Akad. Nauk SSSR, Sib. Otd., Khim.-Met. Inst.
Khimicheskii Analiz Tsvetnykh i Redkikh Metallov, Akademiya Nauk SSSR, Sibirskoe Otdelenie, Khimiko-Metallurgicheskii Institut *(U.S.S.R.)*
Khim. Geterotsikl. Soedin. Akad. Nauk Latv. SSR
*Khimiya Geterotsiklicheskikh Soedinenii, Akademiya Nauk Latviiskoi SSR *(Latvian S.S.R.)*
Khim. Prom.

*Khimicheskaya Promyshlennost *(U.S.S.R.)*
Khim. Tekhnol. Topliv Masel
*Khimiya i Tekhnologiya Topliv i Masel *(U.S.S.R.)*
Khlopkovodstvo
Khlopkovodstvo *(U.S.S.R.)*
Kibernetika
*Kibernetika *(Ukrainian S.S.R.)*
Kikai No Kenkyu
*Kikai no Kenkyo (Science of Machine) *(Japan)*
Kinet. Kataliz
*Kinetika i Kataliz *(U.S.S.R.)*
Kinzoku Butsuri
Kinzoku Butsuri (Metal Physics) *(Japan)*
Kinzoku Zairyo Gijutsu Kenkyusho Kenkyu Hokoku
*Kinzoku Zairyo Gijutsu Kenkyusho Kenkyu Hokoku (Report of National Research Institute for Metals) *(Japan)*
Kiserl. Orvostud.
Kiserletes Orvostudomany *(Hungary)*
Kishocho Kenkyu Jiho
*Kishocho Kenkyu Jiho (Journal of Meteorological Research) *(Japan)*
Kisul Yon'guso Pogo
*Kisul Yon'guso Pogo (Report of the Army Research and Testing Laboratory) (supersedes Kwayon Hwibo) *(Korea)*
Klin. Khir.
Klinicheskaya Khirurgiya *(Ukrainian S.S.R.)*
Klin. Med. (Vienna)
Klinische Medizin (Vienna) *(Austria)*
Klin. Monatsbl. Augenheilk.
Klinische Monatsblaetter fuer Augenheilkunde und fuer Augenaerztliche Fortbilduna *(Germany)*
Klin. Wochensch.
*Klinische Wochenschrift *(Germany)*
Koatsu Gasu Kyokaishi
Koatsu Gasu Kyokaishi (Journal of the Society of High Pressure Gas Industry) *(Japan)*
Kobayashi Rigaku Kenkyushu Hokoku
*Kobayashi Rigaku Kenkyushu Hokoku (Bulletin of the Kobayashi Institute of Physical Research) *(Japan)*
Kobe J. Med. Sci.
Kobe Journal of the Medical Sciences. The *(Japan)*
Kobe Seiko Giio
*Kobe Seiko Giio (Kobe Steel Works Engineering Reports) *(Japan)*
Kobe Shosen Daigaku Kiyo. Dai-2-Rui. Kokai, Kikan, Rigaku-hen
Kobe Shosen Daigaku Kiyo. Dai-2-Rui. Kokai, Kikan, Rigaku-hen. (Review of Kobe University of Mercantile Marine. Part II. Navigation, Marine Engineering, and Scientific Section) *(Japan)*
Kobe Steel Works Eng. Rep.
Kobe Steel Works Engineering Reports
see Kobe Seiko Giio
Kobunshi Kagaku
*Kobunshi Kagaku (Chemistry of High Polymers) *(Japan)*
Koeltechniek
Koeltechniek *(Netherlands)*
Kogyo Gijutsuin, Hakko Kenkyusho Kenkyu Hokoku
*Kogyo Gijutsuin, Hakko Kenkyusho Kenkyu Hokoku (Report of the Fermentation Research Institute) *(Japan)*
Kogyo Kagaku Zasshi
*Kogyo Kagaku Zasshi (Journal of the Chemical Society of Japan, Industrial Chemistry Section) *(Japan)*
Kogyo Zairyo
*Kogyo Zairyo (Engineering Materials) *(Japan)*
Kohasz. Lapok
Kohaszati Lapok *(Hungary)*
K'o Hsueh T'ung Pao
*K'o Hsueh T'ung Pao (Scientia) *(China)*
Kokobyogakkai Zasshi
Kokobyogakkai Zasshi (The Journal of the Japan Stomatological Society) *(Japan)*
Kolloid-Z.
Kolloid-Zeitschrift *(Germany)*
Kolloid. Zh.
*Kolloidnyi Zhurnal (Colloid Journal) *(U.S.S.R.)*
Kolloid-Z. Z. Polym.
*Kolloid-Zeitschrift & Zeitschrift fuer Polymer, Zur Zeit Vereinigt mit den Kolloid-Beiheften (Formerly Kolloid-Zeitschrift) *(Germany)*
Kon. Ned. Akad. Wetensch., Proc., Ser. A
*Koninklijke Nederlandse Akademie von Wetenschappen, Proceedings, Series A *(Netherlands)*
Kon. Ned. Akad. Wetensch., Proc., Ser. B
*Koninklijke Nederlandse Akademie van Wetenschappen, Proceedings, Series B *(Netherlands)*
Kon. Ned. Akad. Wetensch., Proc., Ser. C
*Koninklijke Nederlandse Akademie van Wetenschappen, Proceedings, Series C *(Netherlands)*
Koshu Eiseiin Kenkyu Hokoku
*Koshu Eiseiin Kenkyu Hokoku (Bulletin of the Institute of Public Health) *(Japan)*
Kosm. Issled.
*Kosmicheskie Issledovaniyat *(U.S.S.R.)*
Kosmos (Warsaw) Ser. A
Kosmos (Warsaw) Seria A: Biologia *(Poland)*
Kozan Chishitsu
*Kozan Chishitsu (Mining Geology) *(Japan)*
Kozp. Elelmiszeripari Kutatoint. Kozlem.
Kozponti Elelmiszeripari Kutatointezet Kozlemenyei, A *(Hungary)*
Krebsarzt
Krebsarzt, Der *(Austria)*
Krebsforsch. Krebsbekaempf.
Krebsforschung und Krebsbekaempfung *(West Germany)*
Kristallografiya
*Kristallografiyat *(U.S.S.R.)*
Krupp Tech. Rev. (Engl. Transl. Tech. Mitt. Krupp, Werksber.)
*Krupp Technical Review (English Translation of Technische Mitteilungen Krupp, Werksberichte) *(Germany)*
Kuki Chowa Eisei Kogaku
*Kuki Chowa Eisei Kogaku (Air Conditioning, Sanitary Engineering) *(Japan)*
Kumamoto Iaakkai Zasshi
Kumamoto Iaakkai Zasshi (The Journal of the Kumamoto Medical Society) *(Japan)*
Kumamoto J. Sci., Ser. A
Kumamoto Journal of Science, Series A *(Japan)*
Kunstoffe
*Kunstoffe. Organ der Deutschen Kunstoff-Fachverbaende *(West Germany)*
Kurume Med. J.
Kurume Medical Journal, The *(Japan)*
Kuznechno-Shtampovochnoe Proizvod.
Kuznechno-Shtampovochnoe Proizvodstvo *(U.S.S.R.)*
Kwart. Geol.
*Kwartalnik Geologiczny *(Poland)*
Kybernetik
*Kybernetik *(Germany)*
Kyushu Daigaku Kogaku Shuho
Kyushu Daigaku Kogaku Shuho (Technology Reports of the Kyushu University) *(Japan)*
Kyushu J. Med. Sci.
Kyushu Journal of Medical Science *(Japan)*
Lab. Anim. Care
*Laboratory Animal Care *(U. S.)*
Lab. Invest.
*Laboratory Investigation *(U. S.)*
Lab. Pract.
*Laboratory Practice *(England)*
Lancet
*Lancet, The *(England)*
Landbouforsch. Voelkenrode
Landbauforschung Voelkenrode *(West Germany)*
Landbouwk. Tijdschr.
Landbouwkundig Tijdschrift *(Netherlands)*
Landwirt. Forsch.
Landwirtschaftliche Forschung *(West Germany)*
Laryngoscope
*Laryngoscope, The *(U. S.)*
Lastechniek
Lastechniek *(Netherlands)*
Latv. PSR Zinat. Akad. Vestis
*Latvijas PSR Zinatnu Akademijas Vestis *(Latvian S.S.R.)*
Latv. PSR Zinat. Akad. Vestis, Fiz. Teh. Zinat. Ser.
*Latvijas PSR Zinatnu Akademijas Vestis, Fizikas un Tehnisko Zinatnu Serija *(Latvian S.S.R.)*
Laval Med.
Laval Medical *(Canada)*
Lavori Ist. Anat. Istol. Patol. Univ. Studi Perugia
Lavori dell'Istituto di Anatomia e Istologia Patologica della Universita degli Studi di Perugia *(Italy)*
Leather Sci. (Madras, India)
Leather Science (Madras, India) *(India)*
Leder

Leder, Das *(Germany)*
Lek. Wojsk.
Lekarz Wojskowy *(Poland)*
Lichttechnik
*Lichttechnik *(Germany)*
Liet. Fiz. Rinkinys, Liet. TSR Mokslu Akad., Liet. TSR Aukstosios Mokyklos
*Lietuvos Fizikos Rinkinys, Lietuvos TSR Mokslu Akademija, Lietuvos TSR Aukstosios Mokyklos *(Lithuanian S.S.R.)*
Liet. TSR Mokslu Akad. Darbai: Ser. B
*Lietuvos TSR Mokslu Akademija Darbai: Serija B *(Lithuanian S.S.R.)*
Life Sci.
*Life Sciences *(U. S.)*
Light Metals
*Light Metals *(England)*
Lille Med.
Lille Medical *(France)*
Limnol. Oceanogr.
*Limnology and Oceanography *(U. S.)*
Limnol. Oceanogr., Suppl.
Limnology and Oceanography, Supplement *(U. S.)*
Lit. Mat. Sb.
Litovskii Matematicheskikh Sbornik *(Lithuanian S.S.R.)*
Lloydia
*Lloydia, A Quarterly Journal of Biological Science *(U. S.)*
Lockheed Ga. Quart.
*Lockheed Georgia Quarterly *(U. S.)*
Lodz. Tow. Nauk., Wydz. III, Acta Chim.
*Lodzkie Towarzystwo Naukowe, Wydzial III, Acta Chimica *(Poland)*
Lubrication
*Lubrication *(U. S.)*
Lubric. Eng.
*Lubrication Engineering *(U. S.)*
Lucr. Inst. Cercet. Vet. Bioprep. "L. Pasteur"
Lucrarile Institutului de Cercetari Veterinare si Biopreparate "L. Pasteur" *(Romania)*
Lucr. Stiint. Inst. Agron. Ion Ionescu de la Brad, Iasi
Lucrarile Stiintifice. Institutul Agronomic Professor Ion Ionescu de la Brad, Iasi *(Romania)*
Lucr. Stiint., Ser. C, VII
Lucrari Stiintifice, Seria C, VII. Zootehnie si Medicina Veterinara, Bucuresti *(Romania)*
Luftfahrttech.-Raumfahrttech.
*Luftfahrttechnik-Raumfahrttechnik *(West Germany)*
Lyon Chir.
Lyon Chirurgical *(France)*
Lyon Med.
Lyon Medical *(France)*
Mach. Design
*Machine Design *(U. S.)*
Machinery (Engl.)
*Machinery *(England)*
Mach. Lloyd
Machinery Lloyd *(England)*
Madjalah Inst. Tek. Bandung Proc.
*Madjalah Institut Teknologi Bandung Proceedings *(Indonesia)*
Magnit. Gidrodin.
*Magnitnaya Gidrodinamika *(Latvian S.S.R.)*
Magy. Allatorv. Lapja
Magyar Allatorvosok Lapja *(Hungary)*
Magy. Fiz. Foly.
*Magyar Fizikai Folyoirat *(Hungary)*
Magy. Geofiz.
*Magyar Geofizika *(Hungary)*
Magy. Kem. Foly.
*Magyar Kemiai Folyoirat *(Hungary)*
Magy. Kem. Lapja
*Magyar Kemikusok Lapja *(Hungary)*
Magy. Onkol.
Magyar Onkologia *(Hungary)*
Magy. Radiol.
*Magyar Radiologia *(Hungary)*
Magy. Tud. Akad. At. Kut. Intez. (Debrecen), Kozlem.
Magyar Tudomanyos Akademia Atommag Kutato Intezete (Debrecen). Kozlemenyek
see ATOMKI (At. Kut. Intez.) Kozlem.
Magy. Tud. Akad. Kem. Tud. Oszt. Kozlem.
*Magyar Tudomanyos Akademia Kemiai Tudomanyok Osztalyanak Kozlemenyei, A *(Hungary)*
Magy. Tud. Akad. Kozp. Fiz. Kut. Intez. Kozlem.
Magyar Tudomanyos Akademia Kozponti Fizikai Kutato Intezetenek Kozlemenyei
see KFKI (Kozp. Fiz. Kut. Intez.) Kozlemen.
Magy. Tud. Akad. Mat. Fiz. Tud. Oszt. Kozlem.
*Magyar Tudomanyos Akademia Matematikai es Fizikai Tudomanyok Osztalyanak Kozlemenyei, A *(Hungary)*
Magy. Tud. Akad. Mat. Kut. Intez. Kozlem.
*Magyar Tudomanyos Akademia Matematikai Kutato Intezetenek Kozlemenyei A *(Hungary)*
Magy. Tud. Akad., Muszaki Tud. Oszt. Kozlem.
*Magyar Tudomanyos Akademia Muszaki Tudomanyok Osztalyanak Kozlemenyei *(Hungary)*
Magy. Tud. Akad. Tihanyi Biol. Kutatointez. Evk.
*Magyar Tudomanyos Akademia Tihanyi Biologiai Kutatointezetenek Evkonyve, A *(Hungary)*
Makromol. Chem.
*Makromolekulare Chemie *(Switzerland)*
Malacologia
Malacologia *(U. S.)*
Mal. Cardiov.
Malattie Cardiovascolari *(Italy)*
Marconi Rev.
*Marconi Review *(England)*
Mar. Geol.
Marine Geology *(Netherlands)*
Maryland State Med. J.
Maryland State Medical Journal *(U. S.)*
Maschinenbautechnik
Maschinenbautechnik *(East Germany)*
Mass Spectros.
Mass Spectroscopy
see Shitsuryo Bunseki
Mater. Design Eng.
Materials in Design Engineering (formerly Materials & Methods) *(U. S.)*
Mater. Eng.
*Materials Engineering (formerly Materials in Design Engineering) *(U. S.)*
Materialpruefung
Materialpruefung *(West Germany)*
Mater. Eval.
*Materials Evaluation (formerly Nondestructive Testing) *(U. S.)*
Mater. Protect.
*Materials Protection *(U. S.)*
Mater. Res. Stand.
*Materials Research & Standards (Formerly ASTM (American Society for Testing Materials) Bulletin) *(U. S.)*
Mater. Sci. Eng.
Materials Science and Engineering *(Netherlands)*
Math. Ann.
*Mathematische Annalen *(West Germany)*
Math. Biosci.
*Mathematical Biosciences *(U. S.)*
Math. Comput.
*Mathematics of Computation *(U. S.)*
Mathematica
Mathematica *(Romania)*
Mathematika
*Mathematika, A Journal of Pure and Applied Mathematics *(England)*
Math. Nachr.
*Mathematische Nachrichten *(Germany)*
Math. Rev.
*Mathematical Reviews *(U. S.)*
Math. Z.
*Mathematische Zeitschrift *(Germany)*
Mayo Clin. Proc.
*Mayo Clinic Proceedings *(U. S.)*
Meas. Tech. (USSR) (Engl. Transl.)
*Measurement Techniques (USSR) (English Translation of Izmeritel'naya Tekhnika) *(U. S.)*
Mech. Chem. Eng. Trans.
Mechanical and Chemical Engineering Transactions *(Australia)*
Mech. Eng.
*Mechanical Engineering *(U. S.)*
Mech. Teor. Stosow.
Mechanika Teoretyczna i Stosowana *(Poland)*
Med. Ann.
Medical Annual *(England)*
Med. Ann. Dist. Columbia
Medical Annals of the District of Columbia *(U. S.)*

Med. Biol. (Tokyo)
Medicine and Biology (Tokyo)
see Igaku To Seibutsugaku

Med. Biol. Eng.
Medical and Biological Engineering *(U. S.)*

Med. Biol. Illus.
*Medical and Biological Illustration *(England)*

Med. Clin. (Barcelona)
Medicina Clinica (Barcelona) *(Spain)*

Med. Clin. N. Amer.
*Medical Clinics of North America, The *(U. S.)*

Medd. Groenland
Meddelelser om Groenland *(Denmark)*

Med. Dosw. Mikrobiol.
Medycyna Doswiadczalna i Mikrobiologia *(Poland)*

Medd. Sundhedsstyr.
Meddelelser fra Sundhedsstyrelsen (Supplement to Ugeskrift for Laeger) *(Denmark)*

Mededel. Directeur Tuinbouw
Mededelingen Directeur van de Tuinbouw *(Netherlands)*

Mededel. Landbouwhogesch. Opzoekingssta. Staat Gent
Mededelingen van de Landbouwhogeschool en de Opzoekingsstations van de Staat te Gent *(Belgium)*

Mededel. Vlaam. Chem. Ver.
*Mededelingen van de Vlaamse Chemische Vereniging *(Belgium)*

Med. Electron. Biol. Eng.
*Medical Electronics and Biological Engineering *(England)*

Med. Exp.
Medicina Experimentalis *(Switzerland)*

Med. Glas.
*Medicinski Glasnik *(Yugoslavia)*

Medicamundi
*Medicamundi *(Netherlands)*

Medicina (Mex.)
Medicina *(Mexico)*

Medicine
*Medicine. Analytical Reviews of General Medicine, Neurology, Psychiatry, Dermatology and Pediatics *(U. S.)*

Medicina (Tokyo)
Medicine (Tokyo)
see Sogo Igaku

Med. Interna
Medicina Interna *(Romania)*

Med. J. Aust.
Medical Journal of Australia, The *(Australia)*

Med. J. Hiroshima Univ.
Medical Journal of Hiroshima University
see Hiroshima Daigaku Igaku Zasshi

Med. J. Kagoshima Univ.
Medical Journal of Kagoshima University
see Kagoshima Daigaku Igaku Zasshi

Med. J. Malaya
Medical Journal of Malaya, The *(Malaya)*

Med. J. Shinshu Univ.
*Medical Journal of Shinshu University *(Japan)*

Med. Klin. (Munich)
Medizinische Klinik (Munich) *(Germany)*

Med. Lab.
Medizinische Laboratorium, Das *(West Germany)*

Med. Lavoro
Medicina del Lavoro, La *(Italy)*

Med. Nucl. Radiobiol. Lat.
*Medicina Nucleare Radiobiologica Latina (formerly Radiobiological Latina) *(Italy)*

Med. Officer
Medical Officer *(England)*

Med. Pharmacol. Exp.
*Medicina et Pharmacologia Experimentalis (formerly Medicina Experimentalis) *(Switzerland)*

Med. Pracy
Medycyna Pracy *(Poland)*

Med. Pregl. (Novi Sad)
Medicinski Pregled (Novi Sad) *(Yugoslavia)*

Med. Radiol.
*Meditsinskaya Radiologiya† *(U.S.S.R.)*

Med. Rec. Ann.
Medical Record and Annals *(U. S.)*

Med. Res. Counc., Spec. Rep. Ser.
Medical Research Council, Special Report Series *(England)*

Med. Res. Eng.
*Medical Research Engineering (formerly American Journal of Medical Electronics) *(U. S.)*

Med. Serv. J. (Can.)
Medical Service Journal *(Canada)*

Med. Thorac.
*Medicina Thoracalis; International Review of Thoracic Diseases *(Switzerland)*

Med. Times
Medical Times *(U. S.)*

Med. Welt
Medizinsche Welt, Die *(Germany)*

Med. Wet. (Poland)
Medycyna Weterynaryjna (Poland) *(Poland)*

Med. Zh. Uzb.
Meditsinskii Zhurnal Uzbekistana *(Uzbek SSR)*

Meidensha Jiho
*Meidensha Jiho (Meidensha Review) *(Japan)*

Meidensha Rev.
Meidensha Review
see Meidensha Jiho

Meiji Yakka Daigaku Kenkyu Kiyo
*Meiji Yakka Daigaku Kenkyu Kiyo (The Bulletin of the Meiji College of Pharmacy) *(Japan)*

Mem. Acad. Roy. Med. Belg.
Memoires de l'Academie Royale de Medecine de Belgique *(Belgium)*

Mem. Acad. Sci., Toulouse
Memoires de l'Academie des Sciences, Inscriptions et Belles-Lettres de Toulouse *(France)*

Mem. Activ. Desarrolladas Patronato "Juan de la Cierva" Invest. Tec., Consejo Super. Invest. Cient.
Memoria de las Actividades Desarrolladas por el Patronato "Juan de la Cierva" de Investigacion Tecnica, Consejo Superior de Investigaciones Cientificas *(Spain)*

Mem. Amer. Math. Soc.
Memoirs of the American Mathematical Society *(U. S.)*

Mem. Chubu Elec. Power Co., Ltd.
Memoirs of the Chubu Electric Power Co., Ltd.
see Chubu Denryoku K, K. Kenkyu Shiryo

Mem. Coll. Sci., Univ. Kyoto, Ser. B
Memoirs of the College of Science, University of Kyoto, Series B *(Japan)*

Mem. Fac. Eng. Hiroshima Univ.
*Memoirs of the Faculty of Engineering, Hiroshima University *(Japan)*

Mem. Fac. Eng., Kyoto Univ.
*Memoirs of the Faculty of Engineering, Kyoto University *(Japan)*

Mem. Fac. Eng., Nagoya Univ.
*Memoirs of the Faculty of Engineering, Nagoya University *(Japan)*

Mem. Fac. Liberal Arts Educ., Yamanashi Univ.
Memoris of the Faculty of Liberal Arts and Education, Yamanashi University
see Yamanashi Daigaku Gakugeigakubu Kenkyu Hokoku

Mem. Fac. Sci., Kyushu Univ., Ser. C
Memoirs of the Faculty of Science, Kyushu University, Series C *(Japan)*

Mem. Inst. Sci. Ind. Res. Osaka Univ.
*Memoirs of the Institute of Scientific and Industrial Research, Osaka University *(Japan)*

Mem. Konan Univ., Sci. Ser.
*Memoirs of the Konan University, Science Series *(Japan)*

Mem. Muroran Univ. Eng.
Memoirs of the Muroran University of Engineering
see Muroran Kogyo Daigaku Kenkyu Hokoku

Mem. Osaka Inst. Technol., Sci. Technol.
Memoirs of the Osaka Institute of Technology, Science and Technology
see Osaka Kogyo Daigaku Kiyo, Riko-Hen

Mem. Roy. Astron. Soc.
*Memoirs of the Royal Astronomical Society *(England)*

Mem. Sch. Sci. Eng., Waseda Univ.
*Memoirs of the School of Science and Engineering, Waseda University *(Japan)*

Mem. Sci. Rev. Met.
*Memoires Scientifiques de la Revue de Metallurgie, Les (formerly a part of Revue de Metallurgie) *(France)*

Mem. Soc. Roy. Sci. Liege
*Memoires de la Societe Royale des Sciences de Liege *(Belgium)*

Metab., Clin. Exp.
*Metabolism, Clinical and Experimental *(U. S.)*

Met., ABM (Ass. Brasil. Metais)
Metalurgia, ABM (Associacao Brasileira de Metais) *(Brazil)*
Metal Finish J. (London)
Metal Finishing Journal (London) *(England)*
Metall
*Metall. Internazionale Zeitschrift fuer Technik und Wirtschaft *(West Germany)*
Metalloved. Term. Obrabotka Metal.
*Metallovedenie i Termicheskaya Obrabotka Metallov' (formerly Metallovedenie i Obrabotka Metallov) *(U.S.S.R.)*
Metallurgia
*Metallurgia *(England)*
Metal Phys.
Metal Physics
see *Kinzoku Butsuri*
Metal Progr.
*Metal Progress *(U. S.)*
Metals Eng. Quart.
*Metals Engineering Quarterly *(U. S.)*
Metals Mater.
*Metals and Materials *(England)*
Metal Treat. Drop Forg.
Metal Treatment and Drop Forging *(England)*
Metalurgia (Bucharest)
Metalurgia (Bucharest) *(Romania)*
Metalwork. Prod.
Metalworking Production *(England)*
Metaux (Corros.-Ind.)
*Metaux (Corrosion-Industries) *(France)*
Meteorol. Geoastrophys. Abstr.
Meteorological and Geoastrophysical Abstracts *(U. S.)*
Meteorol. Gidrol.
Meteorologiya i Gidrologiya *(U.S.S.R.)*
Meteorol. Mag.
*Meteorological Magazine *(England)*
Meteorol. Rundschau
Meteorologische Rundschau *(Germany)*
Meteorol. Zpr.
*Meteorologicke Zpravy *(Czechoslovakia)*
Meth. Inform. Med.
*Methods of Information in Medicine-Methodik der Information (Supersedes Medical Documentation) *(West Germany)*
Methods Cell Physiol.
Methods in Cell Physiology *(U. S.)*
Met. Ital.
*Metallurgia Italiana, La *(Italy)*
Met. Metalloved. Chistykh Metal., Sb. Nauch. Rabot
Metallurgiya i Metallovedenie Chistykh Metallov, Moskovskii Inzhenerno-Fizicheskii Institut, Sbornik Nauchnykh Rabot *(U.S.S.R.)*
Met. Rev.
*Metallurgical Reviews *(England)*
Metrologia
Metrologia *(West Germany)*
Met. Soc. Conf.
Metallurgical Society Conferences *(U. S.)*
Mfg. Chem.
*Manufacturing Chemist *(England)*
Microbiology (USSR) (Engl. Transl.)
Microbiology (USSR) (English Translation of Mikrobiologiya) *(U. S.)*
Microchem. J.
*Microchemical Journal *(U. S.)*
Microelectron. Rel.
*Microelectronics and Reliability *(England)*
Microsc. Cryst. Front
Microscope and Crystal Front (formerly Microscope) *(England)*
Microtecnic (Lausanne)
*Microtecnic (Lausanne) *(Switzerland)*
Mie Med. J.
Mie Medical Journal *(Japan)*
Mikrobiologiya
*Mikrobiologiya *(U.S.S.R.)*
Mikrochim. Acta
*Mikrochimica Acta, (Formerly Mikrochimica et Ichnoanalytica Acta) *(Austria)*
Mikrochim. Ichnoanal. Acta
Mikrochimica et Ichnoanalytica Acta (formerly Mikrochimica Acta) *(Austria)*
Mikroskopie
Mikroskopie *(Austria)*
Milchwissenschaft
Milchwissenschaft *(West Germany)*
Mil. Med.
*Military Medicine *(U. S.)*
Mineral. Deposita
Mineralium Deposita *(Germany)*
Mineral. J. (Tokyo)
Mineralogical Journal (Tokyo) *(Japan)*
Mineral. Mag.
*Mineralogical Magazine and Journal of the Mineralogical Society *(England)*
Minerva Chir.
Minerva Chirgica *(Italy)*
Minerva Dermatol.
Minerva Dermatologica *(Italy)*
Minerva Ginecol.
Minerva Ginecologica *(Italy)*
Minerva Idroclimatol.
Minerva Idroclimatologica *(Italy)*
Minerva Med.
Minerva Medica *(Italy)*
Minerva Nucl.
*Minerva Nucleare *(Italy)*
Minerva Pediat.
Minerva Pediatrica *(Italy)*
Minerva Radiol., Fisioterap. Radiobiol.
*Minerva Radiologica, Fisioterapica e Radiobiologica *(Italy)*
Minerva Urol.
Minerva Urologica *(Italy)*
Minina Can.
*Minina in Canada (formerly Precambrian) *(Canada)*
Minina Eng.
Mining Engineer, The, Incorporating the Transactions of the Institution of Mining Engineers *(England)*
Mining Geol.
Mining Geology
see *Kozan Chishitsu*
Mining J. (London)
Mining Journal (London) *(England)*
Mining Safety
Mining and Safety
see *Saiko to Hoan*
Minn. Med.
Minnesota Medicine *(U. S.)*
Missili
*Missili *(Italy)*
Missouri Med.
Missouri Medicine *(U. S.)*
Mitsubishi Denki Giho
*Mitsubishi Denki Giho *(Japan)*
Mitsubishi Heavy Ind. Tech. Rev.
Mitsubishi Heavy Industries Technical Review
see *Mitsubishi Juko Giho*
Mitsubishi Juko Giho
*Mitsubishi Juko Giho (Mitsubishi Heavy Industries Technical Review) *(Japan)*
Mitsui Tech. Rev.
Mitsui Technical Review
see *Mitsui Zosen Giho*
Mitsui Zosen Giho
Mitsui Zosen Giho (Mitsui Technical Review) *(Japan)*
Mitteilungsbl. Strahlungsmessgeraete
Mitteilungsblaetter Strahlungsmessgeraete *(Germany)*
Mitt. Geb. Lebensmitteluntersuch. Hyg.
Mitteilungen aus dem Gebiete der Lebensmitteluntersuchung und Hygiene *(Switzerland)*
Mitt. Naturforsch. Ges. Bern
Mitteilungen der Naturforschenden Gesellschaft in Bern *(Switzerland)*
Mitt. Oesterr. Sanitaetsverwalt.
Mitteilungen der Oesterreischen Sanitaetsverwaltung *(Austria)*
Mitt. Ver. Grosskesselbesitzer
Mitteilungen der Vereinigung der Grosskesselbesitzer *(West Germany)*
Mizushori Gijutsu
*Mizushori Gijutsu (Technical Journal of Water Purification) *(Japan)*
Mod. Cast.
Modern Castings (includes New Technology Section) *(U. S.)*
Mod. Hosp.
Modern Hospital *(U. S.)*
Mod. Mach. Shop

Modern Machine Shop *(U. S.)*

Mod. Med.
Modern Medicine
see Saishin Igaku

Mod. Plast.
*Modern Plastics *(U. S.)*

Mod. Power Eng.
*Modern Power and Engineering *(Canada)*

Med. Probl. Paediat.
*Moderne Probleme der Paediatrie *(Switzerland)*

Mod. Treat.
Modern Treatment *(U. S.)*

Mol. Cryst.
Molecular Crystals *(U. S.)*

Mol. Gen. Genet.
*Molecular and General Genetics (MGG) (continuation of Zeitschrift fuer Vererbungslehre) *(West Germany)*

Mol. Pharmacol.
*Molecular Pharmacology *(U. S.)*

Mol. Phys.
*Molecular Physics *(U. S.)*

Monatsber. Deut. Akad. Wiss. Berlin
*Monatsberichte der Deutschen Akademie der Wissenschaften su Berlin *(Germany)*

Monatsh. Chem.
*Monatshefte fuer Chemie und Verwandte Teile Anderer Wissenschaften *(Austria)*

Monatsh. Veterinaermed.
Monatsheft fuer Veterinaermedizin *(East Germany)*

Monatsschr. Kinderheilk.
Monatsschrift fuer Kinderheilkunde *(West Germany)*

Monatsschr. Ohrenheilk. Laryngo-Rhinol.
Monatsschrift fuer Ohrenheilkunde und Laryngo-Rhinologie *(Austria)*

Mon. Bull. Min. Health
Monthly Bulletin of the Ministry of Health and the Public Health Laboratory Service *(England)*

Mon. Notic. Roy. Astron. Soc.
*Monthly Notices of the Royal Astronomical Society *(England)*

Monogr. Surg. Sci.
*Monographs in the Surgical Sciences *(U. S.)*

Montpellier Med.
Montpellier Medical *(France)*

Mon. Weather Rev.
Monthly Weather Review *(U. S.)*

Morsk. Sb.
Morskoi Sbornik *(U.S.S.R.)*

Mosquito News
Mosquito News *(U. S.)*

MSU (Mich. State Univ.) Vet.
MSU (Michigan State University) Veterinarian *(U. S.)*

Muenchen. Med. Wochenschr.
Muenchener Medizinische Wochenschrift *(West Germany)*

Muroran Kogyo Daigaku Kenkyu Hokoku
*Muroran Kogyo Daigaku Kenkyu Hokoku (Memoirs of the Muroran University of Engineering) *(Japan)*

Mutat. Res.
*Mutation Research *(Netherlands)*

Mycologia
*Mycologia *(U. S.)*

Mycopathol. Mycol. Appl.
*Mycopathologia et Mycologia Applicata *(Netherlands)*

Nagasaki Igakkai Zasshi
Nagasaki Igakkai Zasshi (Journal of the Nagasaki Medical Association) *(Japan)*

Nagoya J. Med. Sci.
Nagoya Journal of Medical Science, The *(Japan)*

Nagoya Kogyo Gijutsu Shikensho Hokoku
*Nagoya Kogyo Gijutsu Shikensho Hokoku (Reports of the Government Industrial Research Institute, Nagoya) *(Japan)*

Nahrung
Nahrung, Die *(East Germany)*

Naika Hokan
Naika Hokan (Japanese Archives of Internal Medicine) *(Japan)*

Nara Gakugei Daigaku Kiyo
*Nara Gakugei Daigaku Kiyo (Journal of the Nara Gakugei University) *(Japan)*

Nara Igaku Zasshi
*Nara Igaku Zasshi (Journal of the Nara Medical Association) *(Japan)*

Nat. Cancer Inst. Monogr.
*National Cancer Institute Monograph *(U. S.)*

Nat. Inst. Anim. Health Quart.
*National Institute of Animal Health Quarterly (Tokyo) *(Japan)*

Nat. Tech. Rep. (Matsushita Elec. Ind. Co., Osaka)
*National Technical Report (Matsushita Electric Industrial Co., Osaka) *(Japan)*

Nature
*Nature (London) *(England)*

Nature (Japan)
Nature (Japan)
see Shizen

Natur. Hist.
Natural History *(U. S.)*

Naturwissenschaften
*Naturwissenschaften, Die *(Germany)*

Naturwiss. Rundsch.
Naturwissenschaftliche Rundschau *(West Germany)*

Nauch. Dokl. Vyssh. Shkoly, Biol. Nauki
Nauchnye Doklady Vysshei Shkoly, Biologicheskie Nauki *(U.S.S.R.)*

Nauch. Tr. Moskov. Tekhnol. Inst. Legkoi Prom.
Nauchnye Trudy Moskovskogo Tekhnologicheskogo Instituta Legkoi Promyshlennosti *(U.S.S.R.)*

Nauch. Tr., Samarkand. Med. Inst.
Nauchnye Trudy, Samarkandskii Meditsinskii Institut imeni Akademika I. P. Pavlova *(U.S.S.R.)*

Nauka Zhizn
Nauka i Zhizn *(U.S.S.R.)*

Nav. Eng. J.
Naval Engineers Journal *(U. S.)*

Nav. Res. Logistics Quart.
*Naval Research Logistics Quarterly *(U. S.)*

Nav. Res. Rev.
Naval Research Reviews *(U. S.)*

N. C. Med. J.
North Carolina Medical Journal, The *(U. S.)*

Nebr. State Med. J.
Nebraska State Medical Journal, The *(U. S.)*

NEC (Nippon Elec. Co.) Res. Dev.
*NEC (Nippon Electric Company), Research and Development *(Japan)*

Ned. Tijdschr. Geneesk.
Nederlandsch Tijdschrift voor Geneeskunde *(Netherlands)*

Ned. Tijdschr. Natuur.
*Nederlands Tijdschrift voor Natuurkunde *(Netherlands)*

Neft. Khoz.
*Neftyanoe Khozyaistvo *(U.S.S.R.)*

Neftekhimiya
*Neftekhimiya *(U.S.S.R.)*

Nekot. Probl. Biokibern., Primen., Elektron. Biol. Med.
Nekotorye Problemy Biokibernetiki, Primenenie Elektroniki v Biologii i Meditsine *(Ukrainian S.S.R.)*

Nematologica
Nematologica *(Netherlands)*

Nenryo Kyokai-Shi
Nenryo Kyokai-Shi (Journal of the Fuel Society of Japan) *(Japan)*

Neoplasma
*Neoplasma *(Czechoslovakia)*

Nepegeszsegugy
*Nepegeszsegugy *(Hungary)*

Nephron
*Nephron *(Switzerland)*

Neth. Milk Dairy J.
Netherlands Milk and Dairy Journal, The *(Netherlands)*

Neue Deliwa-Z.
Neue Deliwa-Zeitschrift zur Foerderung des Gas-, Wasser- und Elektrizitaetsfaches *(West Germany)*

Neue Huette
Neue Huette *(East Germany)*

Neues Jahrb. Geol. Palaeontol., Monatsh.
Neues Jahrbuch fuer Geologie und Palaeontologie, Monatshefte *(Germany)*

Neues Jahrb. Mineral., Abh.
Neues Jahrbuch fuer Mineralogie, Abhandlungen *(West Germany)*

Neue Tech.
*Neue Technik *(Switzerland)*

Neuro-Chir.
*Neuro-Chirurgi *(France)*

Neurochirurgia
*Neurochirurgia. Supplement to Fortschritte der Neurologie

und Psychiatrie *(West Germany)*

Neurol. Med. Chir.
Neurologia Medico Chirurgica *(Japan)*

Neurology
*Neurology *(U. S.)*

New Engl. J. Med.
*New England Journal of Medicine, The *(U. S.)*

Newer Metal Ind.
Newer Metal Industry
see Shin Kinzoku Kogyo

New Phys. (Korea)
*New Physics *(Korea)*

New Phytol.
*New Phytologist, The *(England)*

New Remedies Clin.
New Remedies and Clinic
see Shinyaku To Rinsho

New Sci.
*New Scientist, The *(England)*

Newslett. ENEA Comput. Programme Libr.
Newsletter of the ENEA Computer Programme Library *(Italy)*

Nihon Univ. J. Radiat. Med. Biol.
Nihon University Journal of Radiation Medicine and Biology, The
see Hoshasen Igaku Seibutsugaku

Niigata Daigaku Kogakubu Kenkyu Hokoku
*Niigata Daigaku Kogakubu Kenkyu Hokoku (Research Reports of the Faculty of Engineering, Niigata University) *(Japan)*

Niigata Igakkai Zasshi
Niigata Igakkai Zasshi (Niigata Medical Journal) *(Japan)*

Niigata Med. J.
Niigata Medical Journal
see Niigata Igakkai Zasshi

Nippon Acta Radiol.
Nippon Acta Radiologica
see Nippon Igaku Hoshasen Gakkai Zasshi

Nippon Butsuri Gakkaishi
*Nippon Butsuri Gakkaishi (Proceedings of the Physical Society of Japan) *(Japan)*

Nippon Eiseigaku Zasshi
Nippon Eiseigaku Zasshi (Japanese Journal of Hygiene) *(Japan)*

Nippon Ganka Gakkai Zasshi
Nippon Ganka Gakkai Zasshi (Acta Societatis Ophthalmologicae Japonicae) *(Japan)*

Nippon Ganka Kiyo
Nippon Ganka Kiyo (Folia Ophthalmologica Japonica) *(Japan)*

Nippon Genshiryoku Gakkaishi
*Nippon Genshiryoku Gakkaishi (Journal of the Atomic Energy Society of Japan) *(Japan)*

Nippon Hoshasen Kobunshi Kenkyu Kyokai Nempo
*Nippon Hoshasen Kobunshi Kenkyu Kyokai Nempo (Annual Report of the Japanese Association for Radiation Research on Polymers) *(Japan)*

Nippon Igaku Hoshasen Gakkai Zasshi
*Nippon Igaku Hoshasen Gakkai Zasshi (Nippon Acta Radiologica) *(Japan)*

Nippon Iji Shimpo
*Nippon Iji Shimpo (Japanese Medical Journal) *(Japan)*

Nippon Juigaku Zasshi
*Nippon Juigaku Zasshi (Japanese Journal of Veterinary Science) *(Japan)*

Nippon Kagaku Zasshi
*Nippon Kagaku Zasshi (Journal of the Chemistry Society of Japan, Pure Chemistry Section) *(Japan)*

Nippon Kaiyo Gakkaishi
*Nippon Kaiyo Gakkaishi (Journal of the Oceanographical Society of Japan) *(Japan)*

Nippon Kenchiku Gakkai Ronbun Hokoku-Shu
*Nippon Kenchiku Gakkai Ronbun Hokoku-Shu (Transactions of the Architectural Institute of Japan *(Japan)*

Nippon Ketsueki Gakkai Zasshi
Nippon Ketsueki Gakkai Zasshi (Acta Haematologica Japonica) *(Japan)*

Nippon Kikai Gakkai Ronbunshu
*Nippon Kikai Gakkai Ronbunshu (Transactions of the Japan Society of Mechanical Engineers) *(Japan)*

Nippon Kinzoku Gakkaishi
*Nippon Kinzoku Gakkaishi (Journal of the Japan Institute of Metals (Sendai) *(Japan)*

Nippon Kogyo Kaishi
*Nippon Kogyo Kaishi (Journal of the Mining and Metallurgical Institute of Japan) *(Japan)*

Nippon Kokan Giho
*Nippon Kokan Giho (Nippon Kokan Technical Report) *(Japan)*

Nippon Kokan Tech. Rep.
Nippon Kokan Technical Report
see Nippon Kokan Giho

Nippon Koku Gakkaishi
Nippon Koku Gakkaishi (Journal of Japanese Society for Aeronautical and Space Science) *(Japan)*

Nippon Koshu Eisei Zasshi
Nippon Koshu Eisei Zasshi (Japanese Journal of Public Health) *(Japan)*

Nippon Kyobu Rinsho
*Nippon Kyobu Rinsho (The Japanese Journal of Chest Diseases) *(Japan)*

Nippon Naibumpi Gakkai Zasshi
Nippon Naibumpi Gakkai Zasshi (Folia Endocrinologica Japonica) *(Japan)*

Nippon Naika Gakka Zasshi
Nippon Naika Gakka Zasshi (The Journal of Japanese Society of Internal Medicine) *(Japan)*

Nippon Nogeikagaku Kaishi
*Nippon Nogeikagaku Kaishi (Journal of the Agricultural Chemical Society of Japan) *(Japan)*

Nippon No Kagaku To Gijutsu
Nippon No Kagaku To Gijutsu (Science and Technology of Japan) *(Japan)*

Nippon Oyo Dobutsu Konchugaku Zasshi
Nippon Oyo Dobutsu Konchugaku Zasshi (Japanese Journal of Applied Entomology and Zoology) *(Japan)*

Nippon Ringaku Kaishi
*Nippon Ringaku Kaishi (Journal of the Japanese Forestry Society) *(Japan)*

Nippon Saikingaku Zasshi
Nippon Saikingaku Zasshi (Japanese Journal of Bacteriology) *(Japan)*

Nippon Sanka Fujinka Gakkai Zasshi
Nippon Sanka Fujinka Gakkai Zasshi (Journal of Japanese Obstetrics and Gynecology) *(Japan)*

Nippon Seiko Giho
*Nippon Seiko Giho (Japan Steel Works Technical Review) *(Japan)*

Nippon Shokakibyo Gakkai Zasshi
Nippon Shokakibyo Gakkai Zasshi (The Japanese Journal of Gastroenterology) *(Japan)*

Nippon Shokubutsu Byori Gakkaiho
Nippon Shokubutsu Byori Gakkaiho (Annals of the Phytopathological Society of Japan) *(Japan)*

Nippon Suisan Gakkaishi
Nippon Suisan Gakkaishi (Bulletin of the Japanese Society of Scientific Fisheries) *(Japan)*

NML (Nat. Met. Lab.) Tech. J. (Jamshedpur, India)
NML (National Metallurgical Laboratory) Technical Journal (Jamshedpur, India) *(India)*

Norelco Rep.
Norelco Reporter *(U. S.)*

Norsk Farm. Tidsskr.
*Norsk Farmaceutisk Tidsskrift *(Norway)*

Norsk Geol. Tidsskr.
Norsk Geologisk Tidsskrift *(Norway)*

Northwest Sci.
Northwest Science *(U. S.)*

Notas Fis., Cent. Brasil. Pesqui. Fis.
*Notas de Fisica, Centro Brasileiro de Pesquisas Fisicas *(Brazil)*

No To Shinkei
No To Shinkei (Brain and Nerve) *(Japan)*

Nouv. Rev. Franc. Hematol.
*Nouvelle Revue Francaise d'Hematologie *(France)*

Nova Scotia Med. Bull.
Nova Scotia Medical Bulletin, The *(Canada)*

Novenytermeles
Novenytermeles *(Hungary)*

Nowotwory
*Nowotwory *(Poland)*

NTZ-Commun. J. Engl. Ed.
*NTZ-Communications Journal (English Edition of NTZ-Nachrichtentechnische Zeitschrift) *(West Germany)*

NTZ-Nachrtech. Z.
*NTZ-Nachrichtentechnische Zeitschrift *(Germany)*

Nucl. Appl.
*Nuclear Applications *(U. S.)*

Nucl.-Chicago Tech. Bull.

*Nuclear-Chicago Technical Bulletin *(U. S.)*
Nucl. Data, Sect. A
*Nuclear Data, Section A *(U. S.)*
Nucl. Data, Sect. B
*Nuclear Data, Section B *(U. S.)*
Nucl. Energy
*Nuclear Energy (formerly Nuclear Energy Engineer) *(England)*
Nucl. Eng.
*Nuclear Engineering incorporating Nuclear Power *(England)*
Nucl. Eng. (Tokyo)
Nuclear Engineering (Tokyo)
see *Genshiryoku Kogyo*
Nucl. Eng. Bull.
*Nuclear Engineering Bulletin *(U. S.)*
Nucl. Eng. Design
*Nuclear Engineering and Design (Formerly Nuclear Structural Engineering) *(Netherlands)*
Nucleonics
*Nucleonics *(U. S.)*
Nucleus (Calcutta)
Nucleus (Calcutta) *(India)*
Nucleus (Chicago)
*Nucleus (Chicago), The
Nucleus (Lahore)
*Nucleus (Lahore) *(Pakistan)*
Nucleus (Paris)
*Nucleus. La Revue Scientifique a l'Age Atomique (Paris) *(France)*
Nucl. Fusion
*Nuclear Fusion (Journal of Plasma Physics and Thermonuclear Fusion) *(Austria)*
Nucl. Hematol. (Publ. Nucl. Energy)
Nuclear Hematology, Nuclear, Space and General Hematology, Blood Clotting, Immuno-Hematology (Published in Nuclear Energy) *(England)*
Nucl. Ind.
Nuclear Industry *(U. S.)*
Nucl. Inform.
Nuclear Information *(U. S.)*
Nucl. Instrum. Methods
*Nuclear Instruments & Methods (formerly Nuclear Instruments) *(Netherlands)*
Nucl.-Med.
*Nuclear-Medizin *(Germany)*
Nucl. News
*Nuclear News *(U. S.)*
Nucl. Phys.
Nuclear Physics (Netherlands)
Nucl. Phys., A
*Nuclear Physics, A *(Netherlands)*
Nucl. Phys., B
*Nuclear Physics, B *(Netherlands)*
Nucl. Safety
*Nuclear Safety (A Bimonthly Technical Progress Review) *(U. S.)*
Nucl. Sci. (Taiwan)
Nuclear Science (Taiwan) *(China)*
see *Ho Tsu K'o Hsueh*
Nucl. Sci. Appl.
*Nuclear Science and Applications *(Pakistan)*
Nucl. Sci. Eng.
*Nuclear Science and Engineering *(U. S.)*
Nucl. Struct. Eng.
*Nuclear Structural Engineering *(Netherlands)*
Nukl. Energ.
*Nuklearna Energija *(Yugoslavia)*
Nukleonik
*Nukleonik *(Germany)*
Nukleonika
*Nukleonika† *(Poland)*
Nunt. Radiol.
*Nuntius Radiologicus *(Italy)*
Nuovi Ann. Ig. Microbiol.
Nuovi Annali d'Igiene e Microbiologia *(Italy)*
Nuovo Cim.
Nuovo Cimento, II (Italy)
Nuovo Cim., A
*Nuovo Cimento, II, A *(Italy)*
Nuovo Cim., B
*Nuovo Cimento, II, B *(Italy)*
Nuovo Cim., Suppl.
*Nuovo Cimento, II, Supplemento *(Italy)*

Nursing Res.
Nursing Research *(U. S.)*
Nursing Times
Nursing Times *(England)*
Nutr. Dieta
*Nutritio et Dieta; European Review of Nutrition and Dietetics *(Switzerland)*
Nutr. Rev.
*Nutrition Reviews *(U. S.)*
N. Y. J. Dent.
New York Journal of Denistry, The *(U. S.)*
N. Y. State Dent. J.
New York State Dental Journal *(U. S.)*
N. Y. State J. Med.
*New York State Journal of Medicine *(U. S.)*
N. Z. J. Geol. Geophys.
New Zealand Journal of Geology and Geophysics *(New Zealand)*
N. Z. J. Sci.
New Zealand Journal of Science *(New Zealand)*
N. Z. Med. J.
New Zealand Medical Journal, The *(New Zealand)*
Observatory
Observatory, The *(England)*
Obstet. Gynecol.
*Obstetrics and Gynecology *(U. S.)*
Ochanomizu Igaku Zasshi
Ochanomizu Igaku Zasshi (The Ochanomizu Medical Journal) *(Japan)*
Ochanomizu Med. J.
Ochanomizu Medical Journal, The
see *Ochanomizu Igaku Zasshi*
Odontology (Tokyo)
Odontology (Tokyo)
see *Shigaku*
Odontol. Revy
Odontologisk Revy *(Sweden)*
OECD (Organ. Econ. Coop. Develop.)
OECD (Organisation for Economic Cooperation and Development) Observer *(France)*
Oeffentl. Gesundheitsdienst
Oeffentliche Gesundheitsdienst *(Germany)*
Oerlikon Schweissmitt.
Oerlikon Schweissmitteilungen *(Germany)*
Oesterr. Akad. Wiss., Math.-Naturwiss. Kl., Anz.
*Oesterreichische Akademie der Wissenschaften, Mathematisch-Naturwissenschaftliche Klasse, Anzeiger *(Austria)*
Oesterr. Akad. Wiss., Math.-Naturwiss. Kl., Sitzungsber., Abt. I
*Oesterreichische Akademie der Wissenschaften, Mathematisch-Naturwissenschftliche Klasse, Sitzungsberichte, Abteilung I *(Austria)*
Oesterr. Akad. Wiss., Math.-Naturwiss. Kl., Sitzungsber., Abt. II
Oesterreichische Akademie der Wissenschaften, Mathematisch-Naturwissenschaftliche Klasse, Sitzungsberichte, Abt. II *(Austria)*
Oesterr. Chem.-Ztg.
Oesterreichische Chemiker-Zeitung *(Austria)*
Office Int. Epizoot., Bull.
Office International des Epizooties, Bulletin *(France)*
Ogneupory
*Ogneupory† *(U.S.S.R.)*
Ohio J. Sci.
Ohio Journal of Science, The *(U. S.)*
Ohm (Elec. Mag.)
*Ohm (The Electrical Magazine Ohm) *(Japan)*
Oikos
*Oikos, Acta Oecologica Scandinavica *(Denmark)*
Oil Gas J.
Oil and Gas Journal, The *(U. S.)*
Okayama Igakkai Zasshi
*Okayama Igakkai Zasshi (Journal of the Okayama Medical Society) *(Japan)*
Okeanologiya
Okeanologiya *(U.S.S.R.)*
Oleagineux
Oleagineux *(France)*
Oncologia
Oncologia *(Switzerland)*
Oncology
*Oncology (formerly Oncologia) *(Switzerland)*
Onde Elec.
*Onde Electrique, L' *(France)*

Onken Kiyo
*Onken Kiyo (The Bulletin of the Institute of Balneotherapeutic's) Kyushu University *(Japan)*
Ont. Hydro Res. News
*Ontario Hydro Research News *(Canada)*
Oper. Res.
*Operations Research *(U. S.)*
Oper. Res. Quart.
*Operational Research Quarterly *(England)*
Ophthalmol. Ibero-Amer.
Ophthalmologia Ibero-Americana *(Brazil)*
Opt. Acta.
*Optica Acta. International Journal of Optics *(England)*
Opthalmologica
*Opthalmologica. International Journal of Ophthalmology *(Switzerland)*
Optik
*Optik *(Germany)*
Opt. Spectra
Optical Spectra *(U. S.)*
Opt. Spectrosc. (USSR) (Engl. Transl.)
*Optics and Spectroscopy (USSR) (English Translation of Optika i Spektroskopiya) *(U. S.)*
Oral Surg., Oral Med., Oral Pathol.
*Oral Surgery, Oral Medicine, Oral Pathology *(U. S.)*
Orthodont. Fr.
Orthodontie Francaise *(France)*
Orthop. Surg.
Orthopedic Surgery
see Seikei Geka
Orv. Hetilap
Orvosi Hetilap *(Hungary)*
Osaka City Med. J.
*Osaka City Medical Journal *(Japan)*
Osaka-Furitsu Koshueisei Kenkyusho Kenkyu Hokoku
Osaka-Furitsu Koshueisei Kenkyusho Kenkyu Hokoku (Proceedings of the Osaka Public Health Institute) *(Japan)*
Osaka Kogyo Daigaku Kiyo. Riko-Hen
*Osaka Kogyo Daigaku Kiyo, Riko-Hen (Memoirs of the Osaka Institute of Technology, Science and Technology) *(Japan)*
Osaka Kogyo Gijutsu Shikensho Hokoku
*Osaka Kogyo Gijutsu Shikensho Hokoku (Report of the Government Industrial Research Institute, Osaka) *(Japan)*
Osaka Shiritsu Daigaku Igaku Zasshi
*Osaka Shiritsu Daigaku Igaku Zasshi (The Journal of the Osaka City Medical Center) *(Japan)*
Otolaryngology (Jap.)
Otolaryngology
see Jibi Inko-ka
Otomeshon
Otomeshon (Automation) *(Japan)*
Oyo Butsuri
*Oyo Butsuri (Journal of Applied Physics) *(Japan)*
Pac. J. Math.
*Pacific Journal of Mathematics *(U. S.)*
Pac. Med. Surg.
*Pacific Medicine and Surgery *(U. S.)*
Pakistan J. Sci.
Pakistan Journal of Science *(Pakistan)*
Pakistan J. Sci. Ind. Res.
*Pakistan Journal of Scientific and Industrial Research *(Pakistan)*
Panminerva Med.
Panminerva Medica *(Italy)*
Pap. Meteorol. Geophys. (Tokyo)
*Papers in Meteorology and Geophysics (Tokyo) *(Japan)*
Paraplegia
Paraplegia *(Scotland)*
Parasitology
*Parasitology *(England)*
Pathol. Biol. Semaine Hop.
*Pathologie et Biologie, Archives de Biologie Medicale, Annales de la Recherche Medicale, La Semaine des Hopitaux *(France)*
Pathol. Eur.
Pathologia Europaea *(Belgium)*
Pathol. Microbiol.
*Pathologia et Microbiologia *(Switzerland)*
Pathol. Microbiol., Suppl.
*Pathologia et Microbiologia, Supplementum *(Switzerland)*
Pathologica
Pathologica *(Italy)*
Pathol. Vet.
*Pathologia Veterinaria *(Switzerland)*
Patol. Fiziol. Eksp. Ter.
*Patologicheskaya Fiziologiya i Eksperimentalnaya Terapiya *(U.S.S.R.)*
Patol. Pol.
Patologia Polska *(Poland)*
Pediat. Clin. N. Amer.
*Pediatric Clinics of North America *(U. S.)*
Pediat. Prat.
Pediatria Pratica *(Brazil)*
Pediatria (Santiago, Chile)
Pediatria (Santiago, Chile) *(Chile)*
Pediatrics
*Pediatrics *(U. S.)*
Pedobiologia
Pedobiologia *(East Germany)*
Pedologie
Pedologie *(Belgium)*
Percept. Motor Skills
Perceptual and Motor Skills *(U. S.)*
Period. Polytech. Chem. Eng.
*Periodica Polytechnica. Chemical Engineering. Chemische Ingenieurwesen *(Hungary)*
Period. Polytech. Elec. Eng.
*Periodica Polytechnica. Electrical Engineering *(Hungary)*
Period. Polytech. Eng.
*Periodica Polytechnica. Engineering *(Hungary)*
Perspect. Biol. Med.
*Perspectives in Biology and Medicine *(U. S.)*
Pest Contr.
Pest Control *(U. S.)*
Petrol. Chem. (USSR) (Engl. Transl.)
Petroleum Chemistry (USSR) (English Translation of Neftekhimiya) *(U. S.)*
Petrol. Geol. (USSR) (Engl. Transl.)
Petroleum Geology (USSR) (English Translation of Geologiya Nefti i Gaza) *(U. S.)*
Petrol. Times
Petroleum Times, The *(England)*
Pflugers Arch. Ges. Physiol.
Pflugers Archiv fuer die Gesamte Physiologie
see Archiv fuer die Gesamte Physiologie
Pharmacol. Rev.
*Pharmacological Reviews *(U. S.)*
Pharm. Acta Helv.
*Pharmaceutica Acta Helvetiae *(Switzerland)*
Pharmazie
*Pharmazie, Die *(Germany)*
Pharm. Ind.
*Pharmazeutische Industrie, Die *(West Germany)*
Pharm. Prax., Beil. Pharm.
*Pharmazeutische Praxis, Beilage zur Zeitschrift "Die Pharmazie" *(Germany)*
Pharm. Ztg., Ver. Apotheker-Ztg.
Pharmazeutische Zeitung, Vereinigt mit Apotheker-Zeitung *(West Germany)*
Philippine Agr.
Philippine Agriculturist, The *(Philippines)*
Philippine J. Sci.
*Philippine Journal of Science *(Philippines)*
Philips Res. Rep.
*Philips Research Reports *(Netherlands)*
Philips Res. Rep., Suppl.
*Philips Research Reports, Supplements *(Netherlands)*
Philips Tech. Rev.
*Philips Technical Review *(Netherlands)*
Phil. Mag.
*Philosophical Magazine, The *(England)*
Phil. Trans. Roy. Soc. London, Ser. A
*Philosophical Transactions of the Royal Society of London, Series A *(England)*
Phil. Trans. Roy. Soc. London, Ser. B
*Philosophical Transactions of the Royal Society of London, Series B *(England)*
Phonetica
*Phonetica *(Switzerland)*
Photochem. Photobiol.
Photochemistry and Photobiology *(England)*
Photogr. Korresp.
Photographische Korrespondenz *(Austria)*
Photogr. Sci. Eng.

*Photographic Science and Engineering *(U. S.)*
Phys. Bl.
Physikalische Blaetter *(Germany)*
Phys. Can.
*Physics in Canada *(Canada)*
Phys. Chem. Glasses
*Physics and Chemistry of Glasses *(England)*
Phys. Fluids
*Physics of Fluids, The *(U. S.)*
Phys. Fluids, Suppl.
*Physics of Fluids The, Supplement *(U. S.)*
Physica
*Physica *(Netherlands)*
Physics
*Physics *(U. S.)*
Physiol. Behav.
Physiology and Behavior *(England)*
Physiol. Bohemoslov.
*Physiologia Bohemoslovenica *(Czechoslovakia)*
Physiol. Plant.
*Physiologia Plantarum *(Denmark)*
Physiol. Rev.
*Physiological Reviews *(U. S.)*
Physiol. Zool.
*Physiological Zoology *(U. S.)*
Physiotherapy (London)
Physiotherapy (London) *(England)*
Phys. Kondens. Mater.
*Physik der Kondensierten Materie *(Germany)*
Phys. Lett.
Physics Letters *(Netherlands)*
Phys. Lett., A
*Physics Letters, [Section] A *(Netherlands)*
Phys. Lett., B
*Physics Letters, [Section] B *(Netherlands)*
Phys. Med. Biol.
*Physics in Medicine and Biology *(England)*
Phys. Metals Metallogr. (USSR) (Engl. Transl.)
Physics of Metals and Metallography, The (USSR) (English Translation of Fizika Metallov i Metallovedeniya) *(England)*
Phys. Norv.
*Physica Norvegica *(Norway)*
Phys. Rev.
*Physical Review, The *(U. S.)*
Phys. Rev. Lett.
*Physical Review Letters *(U. S.)*
Phys. Status Solidi
*Physica Status Solidi *(Germany)*
Phytochemistry
Phytochemistry *(England–U. S.)*
Phys. Today
*Physics Today *(U. S.)*
Phyton (Buenos Aires)
Phyton (Buenos Aires) *(Argentina)*
Phytopathology
*Phytopathology *(U. S.)*
Picker Clin. Scintill.
Picker Clinical Scintillator *(U. S.)*
Planet. Space Sci.
*Planetary and Space Science *(England)*
Planseeber. Pulvermet.
*Planseeberichte fuer Pulvermetallurgie Vereiniat mit Powder Metallurgy Bulletin *(Austria)*
Planta
*Planta. Archiv fuer Wissenschaftliche Botanik *(Germany)*
Plant Cell Physiol.
*Plant and Cell Physiology (Tokyo) *(Japan)*
Plant Physiol.
*Plant Physiology *(U. S.)*
Plant Soil
Plant and Soil *(Netherlands)*
Plasma Phys.
*Plasma Physics (formerly Journal of Nuclear Energy, Part C. Plasma Physics–Accelerators–Thermonuclear Research) *(England)*
Plasma Phys.-Accel.-Thermonucl. Res., J. Nucl. Energy: Pt. C
Plasma Physics-Accelerators-Thermonuclear Research, Journal of Nuclear Energy: Part C
see *J. Nucl. Energy: Pt. C*
Plaste Kaut.
Plaste und Kautschuk mit Fachteil Anstrichstoffe *(East Germany)*
Plast. Massy
Plasticheskie Massy† *(U.S.S.R.)*
Plast. Mater.
Plastic Materials
see *Purasuchikku Zairyo*
Plast. Reconstr. Surg.
Plastic and Reconstructive Surgery and the Transplantation Bulletin *(U. S.)*
Plating
Plating *(U. S.)*
Platinum Metals Rev.
*Platinum Metals Review *(England)*
Pizensky Lek. Sb.
Plzensky Lekarsky Sbornik *(Czechoslovakia)*
Pochvovedenie
*Pochvovedenie† *(U.S.S.R.)*
Point Point Telecommun.
*Point to point Telecommunications. A Journal for the Telecommunications. Engineer *(England)*
Pokroky Mat. Fys. Astron.
*Pokroky Matematiky, Fysiky a Astronomie *(Czechoslovakia)*
Pol. Arch. Med. Wewn.
Polskie Archiwum Medycyny Wewnetrznej *(Poland)*
Pol. Arch. Wet.
Polskie Archiwum Weterynaryjne *(Poland)*
Pol. Endocrinol.
Polish Endocrinology *(Poland)*
Poligrafiya
Poligrafiya *(U.S.S.R.)*
Pol. Przegl. Radiol. Med. Nuklearnej
*Polski Przeglad Radiologii i Medycyny Nuklearnej *(Poland)*
Pol. Tyg. Lek.
Polski Tygodnik Lekarski *(Poland)*
Polymer
*Polymer *(England)*
Pomiary, Automat., Kontr.
Pomiary, Automatika, Kontrola *(Poland)*
Poroh. Met., Akad. Nauk Ukr. SSR
*Poroshkovaya Metallurgiya, Akademiya Nauk Ukrainskoi SSR *(Ukrainian S.S.R.)*
Port. Phys.
Portugaliae Physica *(Portugal)*
Postepy Astron.
*Postepy Astronomii *(Poland)*
Postepy Biochem.
*Postepy Biochemii *(Poland)*
Postepy Fiz.
*Postepy Fizyki *(Poland)*
Postepy Hig. Med. Dosw.
*Postepy Higieny i Medycyny Doswiadczalnej *(Poland)*
Postepy Nauk Roln.
Postepy Nauk Rolniczych *(Poland)*
Postgrad. Med.
*Postgraduate Medicine *(U. S.)*
Postgrad. Med. J. (London)
*Postgraduate Medical Journal (London) *(England)*
Post Office Elec. Eng. J.
*Post Office Electrical Engineers Journal *(England)*
Poultry Sci.
*Poultry Science *(U. S.)*
Poumon Coeur
Poumon et le Coeur *(France)*
Powder Met.
*Powder Metallurgy *(England)*
Power
*Power with which are consolidated Science and Industry, The Engineer Review, The Engineer, The Stationary Engineer, and Operating Engineer *(U. S.)*
Power Eng.
*Power Engineering *(U. S.)*
Power Reactor Technol.
Power Reactor Technology (A Quarterly Technical Progress Review) *(U. S.)*
Power Reactor Technol. Reactor Fuel Process.
*Power Reactor Technology and Reactor Fuel Processing *(U. S.)*
Poznan. Tow. Przyj. Nauk, Wydz. Lek., Pr. Kom. Med. Dosw.
Poznanskie Towarzystwo Przyjaciol Nauk, Wydzial Lekarski, Prace Komisji Medycyny Doswiadczalnej *(Poland)*
Prac. Lek.

*Pracovni Lekarstvi *(Czechoslovakia)*
Practitioner
*Practitioner, The *(England)*
Pract. Oto-Rhino-Laryngol.
*Practica Oto-Rhino-Laryngoloica *(Switzerland)*
Prakt. Metallogr.
*Praktische Metallographie *(Germany)*
Praxis Pneumol.
Praxis der Pneumologie, Vereinigt mit "Der Tuberkulosearzt" *(Germany)*
Pr. Cent. Inst. Ochrony Pracy
*Prace Centralnego Instytutu Ochrony Pracy *(Poland)*
Precis. Metal Molding
Precision Metal Molding *(U. S.)*
Prensa Med. Argent.
Prensa Medica Argentina, La *(Argentina)*
Presse Med.
Presse Medicale, La *(France)*
Presse Therm. Clim.
Presse Thermale et Climatique, La *(France)*
Prib. Tekh. Eksp.
*Pribory i Tekhnika Eksperimenta† *(U.S.S.R.)*
Pr. Inst. Hutn.
Prace Instytutow Hutniczych *(Poland)*
Prikl. Biokhim. Mikrobiol.
*Prikladnaya Biokhimiya i Mikrobiologiya *(U.S.S.R.)*
Prikl. Mat. Mekh.
*Prikladnaya Matematika i Mekhanika† *(U.S.S.R.)*
Primena Radioakt. Izotop. Jonizz. Zracenja Med.
Primena Radioaktivnih Izotopa i Jonizuiucih Zracenia u Medicini *(Yugoslavia)*
Pr. Inst. Masz. Przeply.
Prace Instytutu Maszyn Przeplywowych *(Poland)*
Pr. Inst. Mech. Precyz.
Prace Instytutu Mechaniki Precyzyjnej *(Poland)*
Priroda
*Priroda *(U.S.S.R.)*
Probl. Actuels Ophthalmol.
*Problemes Actuels d'Ophthalmologie *(Switzerland)*
Probl. Endokrinol.
*Problemy Endokrinologii (formerly Problemy Endokrinologii i Gormonoterapii) *(U.S.S.R.)*
Probl. Endokrinol. Gormonater.
Problemy Endokrinologii i Gormonoterapii *(U.S.S.R.)*
Probl. Gematol. Pereliv. Krovi
*Problemy Gematologii i Perelivaniya Krovi *(U.S.S.R.)*
Probl. Kosm. Biol.
Problemy Kosmicheskoi Biologii *(U.S.S.R.)*
Probl. Peredachi Inform., Akad. Nauk SSSR
Problemy Peredachi Informatsii, Akademiya Nauk SSSR *(U.S.S.R.)*
Proc. Acad. Natur. Sci. Philadelphia
Proceedings of the Academy of Natural Sciences of Philadelphia *(U. S.)*
Proc. Amer. Ass. Cancer Res.
*Proceedings of the American Association for Cancer Research *(U. S.)*
Proc. Amer. Math. Soc.
*Proceedings of the American Mathematical Society *(U. S.)*
Proc. Amer. Power Conf.
Proceedings of the American Power Conference *(U. S.)*
Proc. Ass. Offic. Seed Analysts
Proceedings of the Association of Official Seed Analysts *(U. S.)*
Proc. Brit. Ceram. Soc.
*Proceedings of the British Ceramic Society *(England)*
Proc. Cambridge Phil. Soc.
*Proceedings of the Cambridge Philosophical Society (England)
Proces-Verb. Seances Soc. Sci. Phys. Natur. Bordeaux
Proces-Verbaux des Seances de la Societe des Sciences Physiques et Naturelles de Bordeaux *(France)*
Proc. Fac. Eng. Tokai Univ.
Proceedings of the Faculty of Engineering of Tokai University
see Tokai Daigaku Kiyo Kogakubu
Proc. Fla. State Hort. Soc.
Proceedings of the Florida State Horticultural Society *(U. S.)*
Proc. Fujihara Mem. Fac. Eng., Keio Univ. (Tokyo)
*Proceedings of the Fujihara Memorial Faculty of Engineering, Keio University (Tokyo) *(Japan)*
Proc. Geol. Ass. Can.
*Proceedings of the Geological Association of Canada *(Canada)*
Proc. Helminthol. Soc. Wash., D. C.
*Proceedings of the Helminthological Society of Washington, D. C. *(U. S.)*
Proc. IEEE (Inst. Elec. Electron. Eng.)
*Proceedings of the IEEE (Institute of Electrical and Electronics Engineers) (formerly Proceedings of the Institute of Radio Engineers) *(U. S.)*
Proc. Indiana Acad. Sci.
*Proceedings of the Indiana Academy of Science *(U. S.)*
Proc. Indian Acad. Sci., Sect. A
*Proceedings of the Indian Academy of Sciences, Section A *(India)*
Proc. Inst. Elec. Eng. (London)
*Proceedings of the Institution of Electrical Engineers, The (London) *(England)*
Proc. Inst. Mech. Eng. (London)
Proceedings of the Institution of Mechanical Engineers (London) *(England)*
Proc. Int. Congr. Human Genet., 2nd, Rome, 1961
Proceedings of the International Congress of Human Genetics, 2nd Congress, Rome, Sept. 6-12, 1961 (Pub. 1963) *(Italy)*
Proc. Int. Seed Test. Ass.
Proceedings of the International Seed Testing Association *(Netherlands)*
Proc. Iowa Acad. Sci.
*Proceedings of the Iowa Academy of Science *(U. S.)*
Proc. Jap. Acad.
*Proceedings of the Japan Academy *(Japan)*
Proc. La. Acad. Sci.
Proceedings of the Louisiana Academy of Sciences, The *(U. S.)*
Proc. Leeds Phil. Lit. Soc., Sci. Sect.
Proceedings of the Leeds Philosophical and Literary Society, Scientific Section *(England)*
Proc. London Math. Soc.
*Proceedings of the London Mathematical Society *(England)*
Proc. Nat. Acad. Sci. U. S.
*Proceedings of the National Academy of Sciences of the United States of America *(U. S.)*
Proc. Nat. Inst. Sci. India, Part A
*Proceedings of the National Institute of Sciences of India, Part A *(India)*
Proc. Nat. Inst. Sci. India, Part B
*Proceedings of the National Institute of Sciences of India, Part B *(India)*
Proc. Nutr. Soc. (Engl.-Scot.)
*Proceedings of the Nutrition Society *(England)*
Proc. Okla. Acad. Sci.
Proceedings of the Oklahoma Academy of Science *(U. S.)*
Proc. Osaka Public Health Inst.
Proceedings of the Osaka Public Health Institute
see Osaka-Furitsu Koshueisei Kenkyusho Kenkyu Hokoku
Proc. Phys. Seminar Trondheim
Proceedings of the Physics Seminar in Trondheim
see Ark. Fys. Seminar Trondheim
Proc. Phys. Soc. (London)
*Proceedings of the Physical Society (London), The *(England)*
Proc. Phys. Soc. Jap.
Proceedings of the Physical Society of Japan
see Nippon Butsuri Gakkaishi
Proc. Res. Inst. Nucl. Med. Biol.
*Proceedings of Research Institute for Nuclear Medicine and Biology *(Japan)*
Proc. Roy. Inst. Great Brit.
Proceedings of the Royal Institution of Great Britain *(England)*
Proc. Roy. Irish Acad., Sect. A
*Proceedings of the Royal Irish Academy, Section A *(Ireland)*
Proc. Roy. Irish Acad., Sect. B
*Proceedings of the Royal Irish Academy, Section B *(Ireland)*
Proc. Roy. Soc. Edinburgh, A
*Proceedings of the Royal Society of Edinburgh, Section A *(Scotland)*
Proc. Roy. Soc. (London), Ser. A
*Proceedings of the Royal Society (London), Series A *(England)*
Proc. Roy. Soc. (London), Ser. B
*Proceedings of the Royal Society (London), Series B *(England)*
Proc. Roy. Soc. Med.
*Proceedings of the Royal Society of Medicine *(England)*
Proc. Rudolf Virchow Med. Soc. N. Y.
*Proceedings of the Rudolf Virchow Medical Society in the City of New York *(Switzerland)*
Proc. Soc. Exp. Biol. Med.

*Proceedings of the Society for Experimental Biology and Medicine *(U. S.)*
Proc. Vibration Probl.
Proceedings of Vibration Problems *(Poland)*
Prod. Finish. (Cincinnati)
Products Finishing (Cincinnati) *(U. S.)*
Prod. Probl. Pharm.
Produits et Problemes Pharmaceutiques *(France)*
Progr. Allergy
*Progress in Allergy: Fortschritte der Allergielehre *(Switzerland)*
Progr. Appl. Mater. Res.
Progress in Applied Materials Research *(England)*
Progr. Astronaut. Aeronaut.
*Progress in Astronautics and Aeronautics *(U. S.)*
Progr. Biophys. Mol. Biol.
Progress in Biophysics and Molecular Biology (formerly Progress in Biophysics and Biophysical Chemistry) *(U. S.)*
Progr. Clin. Cancer
Progress in Clinical Cancer *(U. S.)*
Progr. Clin. Pathol.
Progress in Clinical Pathology *(U. S.)*
Progr. Cryog.
*Progress in Cryogenics *(England)*
Progr. Crystal Phys.
*Progress in Crystal Physics *(U. S.-England)*
Progr. Elem. Particle Cosmic Ray Phys.
*Progress in Elementary Particle and Cosmic Ray Physics *(U. S.–Netherlands)*
Progr. Exp. Tumor Res.
*Progress in Experimental Tumor Research *(Switzerland)*
Progr. Inorg. Chem.
*Progress in Inorganic Chemistry *(U. S.)*
Progr. Low Temp. Phys.
*Progress in Low Temperature Physics *(Netherlands)*
Progr. Mater. Sci.
*Progress in Materials Science *(England)*
Progr. Med. Virol.
*Progress in Medical Virology *(Switzerland)*
Progr. Nucleic Acid Res. Mol. Biol.
*Progress in Nucleic Acid Research and Molecular Biology (formerly Progress in Nucleic Acid Research) *(U. S.)*
Progr. Nucl. Energy, Ser. I
*Progress in Nuclear Energy, Series I *(England–U. S.)*
Progr. Nucl. Energy, Ser. II
*Progress in Nuclear Energy, Series II *(England–U. S.)*
Progr. Nucl. Energy, Ser. III
*Progress in Nuclear Energy, Series III *(England–U. S.)*
Progr. Nucl. Energy, Ser. IV
*Progress in Nuclear Energy, Series IV *(U. S.)*
Progr. Nucl. Energy, Ser. V
*Progress in Nuclear Energy, Series V *(England–U. S.)*
Progr. Nucl. Energy, Ser. VI
*Progress in Nuclear Energy, Series VI *(England–U. S.)*
Progr. Nucl. Energy, Ser. VII
*Progress in Nuclear Energy, Series VII *(England–U. S.)*
Progr. Nucl. Energy, Ser. VIII
*Progress in Nuclear Energy, Series VIII *(England–U. S.)*
Progr. Nucl. Energy, Ser. IX
*Progress in Nuclear Energy, Series IX *(U. S.)*
Progr. Nucl. Energy, Ser. X
*Progress in Nuclear Energy, Series X *(England–U. S.)*
Progr. Nucl. Energy, Ser. XII
*Progress in Nuclear Energy, Series XII *(England–U. S.)*
Progr. Nucl. Phys.
*Progress in Nuclear Physics *(U. S.)*
Progr. Radiat. Ther.
*Progress in Radiation Therapy *(U. S.)*
Progr. React. Kinet.
*Progress in Reaction Kinetics *(U. S.)*
Progr. Sci. Technol. Rare Earths
*Progress in the Science and Technology of the Rare Earths *(U. S.)*
Progr. Stereochem.
*Progress in Stereochemistry *(U. S.)*
Progr. Surg.
*Progress in Surgery *(Switzerland)*
Progr. Theoret. Phys. (Kyoto)
*Progress of Theoretical Physics (Kyoto) *(Japan)*
Progr. Theoret. Phys. (Kyoto), Suppl.
*Progress of Theoretical Physics (Kyoto), Supplement *(Japan)*
Protides Biol. Fluids, Proc. Colloq.
Protides of the Biological Fluids, Proceedings of the Colloquium *(Belgium)*
Protoplasma
*Protoplasma *(Austria)*
Przegl. Elektron.
*Przeglad Elektroniki *(Poland)*
Przegl. Geofiz.
*Przeglad Geofizyczny *(Poland)*
Przegl. Geol.
*Przeglad Geologiczny *(Poland)*
Przegl. Odlewnictwa
Przeglad Odlewnictwa *(Poland)*
Przegl. Spawalnictwa
Przeglad Spawalnictwa *(Poland)*
Przegl. Wojsk Lodowych
Przeglad Wojsk Lodowych *(Poland)*
Przem. Chem.
*Przemysl Chemiczny *(Poland)*
Psychiat. Neurol.
*Psychiatria et Neurologia *(Switzerland)*
Psychol. Bull.
*Psychological Bulletin *(U. S.)*
Psychol. Prax.
*Psychologie und Praxis *(West Germany)*
Psychol. Rec.
*Psychological Record *(U. S.)*
Psychol. Rep.
Psychological Reports *(U. S.)*
Psychol. Rev.
*Psychological Review *(U. S.)*
Psychonomic Sci.
Psychonomic Science *(U. S.)*
Psychopharmacologia
*Psychopharmacologia *(West Germany)*
Pubbl. Sta. Zool. Napoli
Pubblicazioni della Stazione Zoologica di Napoli *(Italy)*
Pub. Lab. Fis. Cosm., Univ. Mayor San Andres
*Publicaciones del Laboratorio de Fisica Cosmica, Universidad Mayor de San Andres *(Bolivia)*
Publ. Astron. Soc. Jap.
Publications of the Astronomical Society of Japan *(Japan)*
Publ. Astron. Soc. Pac.
Publications of the Astronomical Society of the Pacific *(U. S.)*
Public Health Rep. (U. S.)
*Public Health Reports *(U. S.)*
Publ. Inst. Mar. Sci., Univ. Tex.
Publications of the Institute of Marine Science, University of Texas *(U. S.)*
Publ. Museu Lab. Mineral. Geol. Univ. Coimbra Centro Estud. Geol., Mem. Notic.
Publicacoes do Museu e Laboratorio Mineralogico e Geologico da Universidade de Coimbra e do Centro de Estudos Geologico, Memorias e Noticias *(Portugal)*
Pub. Res. Inst. Math. Sci., Ser. A
*Publications of the Research Institute for Mathematical Sciences, Series A *(Japan)*
Pub. Res. Inst. Math. Sci., Ser. B
*Publications of the Research Institute for Mathematical Sciences, Series B *(Japan)*
Purasuchikku Zairyo
*Purasuchikku Zairyo (Plastic Materials) *(Japan)*
Purdue Univ., Eng. Bull., Ext. Ser.
Purdue University. Engineering Bulletin, Extension Series *(U. S.)*
Pure Appl. Chem.
*Pure and Applied Chemistry (The Official Journal of the International Union of Pure and Applied Chemistry) *(U. S.)*
Pure Appl. Geophys.
*Pure and Applied Geophysics (formerly Geofizika Pura e Aplicata) *(Switzerland)*
Quad. Clin. Obstet. Ginecol.
Quaderni di Clinica Obstetrica e Ginecologica *(Italy)*
Quad. Radiol.
Quaderni di Radiologia *(Italy)*
Qualitas Plant. Mater. Veg.
*Qualitas Plantarum et Materiae Vegetabiles *(Netherlands)*
Quart. Appl. Math.
*Quarterly of Applied Mathematics *(U. S.)*
Quart. J. Exp. Physiol.
*Quarterly Journal of Experimental Physiology and Cognate Medical Sciences *(England)*

Quart. J., Fla. Acad. Sci.
Quarterly Journal, Florida Academy of Sciences *(U. S.)*
Quart. J. Math.
*Quarterly Journal of Mathematics *(England)*
Quart. J. Mech. Appl. Math.
*Quarterly Journal of Mechanics and Applied Mathematics *(England)*
Quart. J. Med.
*Quarterly Journal of Medicine, The *(England)*
Quart. J. Microscop. Sci.
Quarterly Journal of Microscopical Science, The *(England)*
Quart. J. Roy. Astron. Soc.
*Quarterly Journal of the Royal Astronomical Society, The *(England)*
Quart. J. Roy. Meteorol. Soc.
*Quarterly Journal of the Royal Meteorological Society *(England)*
Quart. Rev. (London)
*Quarterly Reviews (London) *(England)*
Quart. Rev. Biol.
*Quarterly Review of Biology, The *(U. S.)*
Queensland J. Agr. Anim. Sci.
*Queensland Journal of Agricultural and Animal Science (formerly Queensland Journal of Agricultural Science) *(Australia)*
Radex Rundsch.
Radex Rundschau *(Austria)*
Radiat. Bot.
*Radiation Botany *(England)*
Radiat. Res.
*Radiation Research *(U. S.)*
Radiat. Res. Polym.
Radiation Research on Polymers
see Hoshasen Kobunshi
Radiaz. Alta Energ.
*Radiazioni di Alta Energia *(Italy)*
Radioact. Sea
*Radioactivity in the Sea *(Austria)*
Radiobiol. Lat.
Radiobiologica Latina *(Italy)*
Radiobiologiya
*Radiobiologiya† *(U.S.S.R.)*
Radiobiol. Radiother. Fis. Med.
*Radiobiologia, Radioterapia e Fisica Medica (formerly Radioterapia, Radiobiologia e Fisica Medica) *(Italy)*
Radiobiol.-Radiother.
*Radiobiologia–Radiotherapie *(Germany)*
Radiocarbon
*Radiocarbon *(U. S.)*
Radiochim. Acta
*Radiochimica Acta *(Germany)*
Radio Electron. Eng.
*Radio and Electronic Engineer, The *(England)*
Radiographer
Radiographer *(Australia)*
Radiography
Radiography *(England)*
Radioisotopes (Tokyo)
*Radioisotopes (Tokyo) *(Japan)*
Radiokhimiya
*Radiokhimiya† *(U.S.S.R.)*
Radiol. Austr.
Radiologia Austriaca *(Austria)*
Radiol. Clin. Biol.
*Radiologia Clinica et Biologica (formerly Radiologia Clinica) *(Switzerland)*
Radiol. Clin. N. Amer.
*Radiologic Clinics of North America *(U. S.)*
Radiol. Diagn.
*Radiologia Diagnostica *(Germany)*
Radiol. Health Data
Radiological Health Data *(U. S.)*
Radiol. Health Data Rep.
*Radiological Health Data and Reports (formerly Radiological Health Data) *(U. S.)*
Radiol. Med.
*Radiologia Medica, La *(Italy)*
Radiologe
Radiologe *(Germany)*
Radiologia (Panama)
Radiologia *(Panama)*
Radiology
*Radiology *(U. S.)*
Radiol. Prat.
Radiologia Pratica *(Italy)*
Radiol. Technol.
Radiologic Technology (formerly X-Ray Technician) *(U. S.)*
Radio Sci.
*Radio Science (formerly Journal of Research of the National Bureau of Standards, D) *(U. S.)*
Radiotekhn. Elektron.
*Radiotekhnika i Elektronika† *(U.S.S.R.)*
Rad. Med. Fak. Zagrebu
Radovi Medicinskoga Fakulteta u Zagrebu *(Yugoslavia)*
Rad. Zavoda Fiz.
Radovi Zavoda za Fiziku *(Yugoslavia)*
Rame
Rame *(Italy)*
Rass. Fisiopatol. Clin. Ter.
Rassegna di Fisiopatologia Clinica e Terapeutica *(Italy)*
Rass. Med. Ind. Ig. Lav.
Rassegna di Medicina Industriale e di Igiene del Lavoro *(Italy)*
Raumfahrtforschung
*Raumfahrtforschung (formerly Raketentechnik und Raumfahrtforschung) *(Germany)*
RCA Eng.
RCA Engineer *(U. S.)*
RCA Rev.
*RCA Review *(U. S.)*
Reactor
Reactor *(England)*
Reactor Fuel Process.
*Reactor Fuel Processing (A Quarterly Technical Progress Review) *(U. S.)*
Reactor Mater.
*Reactor Materials (A Quarterly Technical Progress Review) *(U. S.)*
Reactor Sci. Technol., J. Nucl. Energy: Pt. A & B
Reactor Science and Technology, Journal of Nuclear Energy: Parts A & B
see J. Nucl. Energy: Pt. A & B
Reakts. Sposobnost Org. Soedin., Tartu. Gos. Univ.
*Reaktsionnaya Sposobnost Organicheskikh Soedinenii, Tartuskii Gosudarstvennyi Universitet *(Estonian S.S.R.)*
Rec. Chem. Progr.
*Record of Chemical Progress *(U. S.)*
Rec. Elec. Commun. Eng. Conversation, Tohoku Univ.
Record of Electrical and Communication Engineering Conversation, Tohoku University, The
see Tohoku Daigaku Dentsu Denwakei Kiroku
Rech. Aerospatiale
*Recherche Aerospatiale *(France)*
Rec. Oceanogr. Works Jap.
Records of Oceanographic Works in Japan *(Japan)*
Reconstruct. Surg. Traumatol.
*Reconstruction Surgery and Traumatology *(U. S.)*
Rec. Trav. Chim.
*Recueil des Travaux Chimiques des Pays-Bas *(Netherlands)*
Redia
Redia, Giornale di Entomologia *(Italy)*
Regelungstechnik
Regelungstechnik *(West Germany)*
Reinf. Plast. (London)
Reinforced Plastics (London) *(England)*
Rend. Ist. Lombardo Sci. Lett., A
Rendiconti dell'Istituto Lombardo di Scienze e Lettere, A *(Italy)*
Rend. Ist. Lombardo Sci. Lett., B
Rendiconti dell'Istituto Lombardo di Scienze e Lettere, B *(Italy)*
Rend. Ist. Sci. Univ. Camerino
Rendiconti degli Istituti Scientifici della Universita di Camerino *(Italy)*
Rend. Ist. Super. Sanita
Rendiconti Istituto Superiore di Sanita *(Italy)*
Rentgenol. Radiol.
Rentgenologiya i Radiologiya *(Bulgaria)*
Rep. Army Res. Testing Lab.
Report of the Army Research and Testing Laboratory
see Kisul Yon'guso Pogo
Rep. Chiba Inst. Technol.
*Report of the Chiba Institute of Technology *(Japan)*
Rep. Constr. Eng. Res. Inst. Found. (Kobe)

*Reports of the Construction Engineering Research Institute Foundation (Kobe) *(Japan)*

Rep. Ferment. Res. Inst.
Report of the Fermentation Research Institute
see ***Kogyo Gijutsuin, Hakko Kenkyusho Kenkyu Hokoku***

Rep. Gov. Chem. Ind. Res. Inst., Tokyo
Reports of the Government Chemical Industrial Research Institute, Tokyo
see ***Tokyo Kogyo Shikensho Hokoku***

Rep. Gov. Ind. Res. Inst., Nagoya
Reports of the Government Industrial Research Institute, Nagoya
see ***Nagoya Kogyo Gijutsu Shikensho Hokoku***

Rep. Gov. Ind. Res. Inst., Osaka
Report of the Government Industrial Research Institute, Osaka
see ***Osaka Kkogyo Gijutsu Shikensho Hokoku***

Rep. Inst. Phys. Chem. Res. (Tokyo)
Reports of the Institute of Physical and Chemical Research (Tokyo)
see ***Riko Gaku Kenkyusho Hokoku***

Rep. Ionosphere Space Res. Jap.
*Report of Ionosphere and Space Research in Japan *(Japan)*

Rep. Kihara Inst. Biol. Res.
Reports of the Kihara Inst. for Biological Research
see ***Seiken Jiho***

Rep. Liberal Arts Sci. Fac. Shizuoka Univ., Natur. Sci.
*Reports of the Liberal Arts and Science Faculty, Shizuoka University *(Japan)*

Rep. Nat. Res. Inst. Metals
Report of National Research Institute for Metals
see ***Kinzoku Zairyo Gijutsu Kenkyusho Kenkyu Hokoku***

Rep. Progr. Appl. Chem.
Reports on the Progress of Applied Chemistry *(England)*

Rep. Progr. Phys.
*Reports on Progress in Physics *(England)*

Rep. Res. Inst. Appl. Mech. (Kyushu Univ.)
Report of Research Institute for Applied Mechanics (Kyushu University) *(Japan)*

Rep. Res. Inst. Elec. Commun., Tohoku Univ.
*Reports of the Research Institute of Electrical Communication, Tohoku University, The *(Japan)*

Rep. Silk Sci. Res. Inst.
Reports of the Silk Science Research Institute
see ***Sanshi Kagaku Kenkyusho Iho***

Rep. Tokyo Metrop. Ind. Res. Inst.
Reports of the Tokyo Metropolitan Industrial Research Institute
see ***Tokyo-To Kogyo Shoreikan Hokoku***

Rep. Transport. Tech. Res. Inst. (Tokyo)
*Report of Transportation Technical Research Institute (Tokyo) *(Japan)*

Res./Develop.
Research/Development *(U. S.)*

Res. Ind. (New Delhi)
Research and Industry (New Delhi) *(India)*

RES, J. Reticuloendothel. Soc.
*RES, Journal of the Reticuloendothelial Society *(U. S.)*

Resp. Physiol.
*Respiration Physiology *(Netherlands)*

Res. Reactor J.
Research Reactor Journal *(U. S.)*

Res. Rep. Fac. Eng., Niigata Univ.
Research Reports of the Faculty of Engineering, Niigata University
see ***Niigata Daigaku Kogakubu Kenkyu Hokoku***

Res. Rev. (Office Aerosp. Res.)
Research Review (Office of Aerospace Research) *(U. S.)*

Res. Technol. Briefs
Research and Technology Briefs *(U. S.)*

Res. Vet. Sci.
*Research in Veterinary Science *(England)*

Reumatismo
Reumatismo *(Italy)*

Rev. Agr. (Brussels)
Revue de l'Agriculture (Brussels) *(Belgium)*

Rev. Alumin.
Revue de l'Aluminium *(France)*

Rev. Argent. Alergia
Revista Argentina de Alergia *(Argentina)*

Rev. Argent. Anestesiol.
Revista Argentina de Anestesiologia *(Argentina)*

Rev. Argent. Tuberc. Enferm. Pulmonares
Revista Argentina de Tuberculosis y Enfermedades Pulmonares *(Argentina)*

Rev. Asoc. Med. Rio Grande do Sul
Revista da Asociacao Medica do Rio Grande do Sul *(Brazil)*

Rev. At. Ind.
Review of Atomic Industries
see ***Genshiryoku Chosa Jiho***

Rev. Belge Med. Dent.
Revue Belge de Medecine Dentaire *(Belgium)*

Rev. Belge Pathol. Med. Exp.
Revue Belge de Pathologie et de Medecine Experimentale *(Belgium)*

Rev. Brasil. Biol.
Revista Brasileira de Biologia *(Brazil)*

Rev. Brasil. Gastroenterol.
Revista Brasileira de Gastroenterologia *(Brazil)*

Rev. Brasil. Malariol. Doences Trop.
Revista Brasileira de Malariologia e Doencas Tropicais *(Brazil)*

Rev. Brasil. Med.
Revista Brasileira de Medicina *(Brazil)*

Rev. Can. Biol.
*Revue Canadienne de Biologie *(Canada)*

Rev. Chil. Pediat.
Revista Chilena de Pediatria *(Chile)*

Rev. Chim. (Bucharest)
*Revista de Chimie (Bucharest) *(Romania)*

Rev. Col. Med. Guatemala
Revista del Colegio Medico de Guatemala *(Guatemala)*

Rev. Corps Sante Armees
Revue des Corps de Sante des Armees *(France)*

Rev. Cubana Cardiol.
Revista Cubana de Cardiologia *(Cuba)*

Rev. Elec. Commun. Lab. (Tokyo)
*Review of the Electrical Communication Laboratory, Nippon Telegraph Telephone Public Corp. (Tokyo) *(Japan)*

Rev. Electrotech. Energ., Acad. Repub. Pop. Roum.
Revue d'Electrotechnique et d'Energetique, Academie de la Republique Populaire Roumaine *(Romania)*

Rev. Espan. Fisiol.
*Revista Espanola de Fisiologia *(Spain)*

Rev. Espan. Oto-neuro-oftalmol. Neurocir.
Revista Espanola de Oto-neuro-oftalmologia y Neurocirugia *(Spain)*

Rev. Espan. Reum. Enferm. Osteoarticul.
Revista Espanola de Reumatismo y Enfermedades Osteo-articulares *(Spain)*

Rev. Espan. Tuberc.
Revista Espanola de Tuberculosis y Archivos Nacionales de Enfermedades del Torax *(Spain)*

Rev. Fac. Cienc. 2A Ser. A-Cienc. Mat.
*Revista da Faculdade de Ciencias, Universidade de Lisboa, 2A Serie, A–Ciencias Matematicas *(Portugal)*

Rev. Fac. Cienc. 2A Ser. B-Cienc. Fis.-Quim.
*Revista da Faculdade de Ciencias, Universidade de Lisboa, 2A Serie, B–Ciencias Fisico-Quimicas *(Portugal)*

Rev. Fac. Cienc. 2A Ser. C-Cienc. Natur.
*Revista da Faculdade de Ciencias, Universidade de Lisboa, 2A Serie, C–Ciencias Naturais *(Portugal)*

Rev. Fr. Astronaut.
*Revue Francaise d'Astronautique *(France)*

Rev. Fr. Endocrinol. Clin.
Revue Francaise d'Endocrinologie Clinique, Nutrition et Metabolisme *(France)*

Rev. Fr. Etud. Clin. Biol.
*Revue Francaise d'Etudes Cliniques et Biologiques *(France)*

Rev. Gen. Bot.
Revue Generale Botanique *(France)*

Rev. Gen. Elec.
Revue Generale de l'Electricite *(France)*

Rev. Geophys.
*Reviews of Geophysics *(U. S.)*

Rev. Ginecol. Obstet. (Rio de Janeiro)
Revista de Ginecologia e d'Obstetricia (Rio de Janeiro) *(Brazil)*

Rev. Goiana Med.
Revista Goiana de Medicina *(Brazil)*

Rev. Hautes Temp. Refract.
Revue des Hautes Temperatures et des Refractaires *(France)*

Rev. Hosp. Clin., Fac. Med., Univ. Sao Paulo
Revista do Hospital das Clinicas, Faculdade de Medicina, Universidade de Sao Paulo *(Brazil)*

Rev. Hosp. Nino (Lima)
Revista del Hospital del Nino (Lima) *(Peru)*

Rev. Hosp. San Juan de Dios (Bogota)
Revista del Hospital de San Juan de Dios (Bogota) *(Colombia)*

Rev. Hyg. Med. Soc.
Revue d'Hygiene et de Medecine Sociale *(France)*

Rev. Iberica Endocrinol.
Revista Iberica de Endocrinologia *(Spain)*

Rev. Immunol.
*Revue d'Immunologie et de Therapie Antimicrobienne *(France)*

Rev. Inst. Franc. Petrole Ann. Combust. Liquides
*Revue de l'Institut Francais du Petrole et Annales des Combustions Liquides *(France)*

Rev. Inst. Ing. Elec.
Revista del Instituto de Ingenieria Electrica *(Argentina)*

Rev. Inst. Med. Trop. Sao Paulo
Revista do Instituto de Medicina Tropical de Sao Paulo *(Brazil)*

Rev. Int. Hautes Temp. Refract.
*Revue Internationale des Hautes Temperatures et des Refractaires (Formerly Revue des Hautes Temperatures et des Refractaires) *(France)*

Rev. Int. Serv. Sante Armees Terre Mer Air
Revue Internationale des Services de Sante des Armees de Terre de Mer et de l'Air *(Belgium)*

Rev. Invest. Clin. Org. Hosp. Enferm. Nutr. Mex.
Revista de Investigacion Clinica, Organo del Hospital de Enfermedades de la Nutricion, Mexico *(Mexico)*

Rev. Kobe Univ. Mercantile Marine. Pt. II. Navigation, Marine Eng. Sci. Sect.
Review of Kobe University of Mercantile Marine. Part II. Navigation, Marine Engineering, and Scientific Section
see Kobe Shosen Daigaku Kiyo. Dai-2-Rui. Kokai, Kikan, Rigaku-hen

Rev. Latinoamer. Anat. Patol.
Revista Latinoamericana de Anatomia Patologica *(Venezuela)*

Rev. Latino-Amer. Cir. Plastica
Revista Latinoamericana de Cirugia Plastica *(Mexico)*

Rev. Latinoamer. Microbiol.
Revista Latinoamericana de Microbiologia *(Mexico)*

Rev. Leprol. (Fontilles)
Revista de Leprologia (Fontilles) *(Spain)*

Rev. Lyon Med.
Revue Lyonnaise de Medecine, La *(France)*

Rev. M.B.L.E.
*Revue de Manufacture Belge de Lampes et de Materiel *(Belgium)*

Rev. Med. Aeronaut. (Paris)
Revue de Medecine Aeronautique (Paris) *(France)*

Rev. Med. Aeronaut. (Rio de Janeiro)
Revista Medica da Aeronautica (Rio de Janeiro) *(Brazil)*

Rev. Med. Cordoba
Revista Medica de Cordoba *(Argentina)*

Rev. Med. Hosp. Colonia (Mex.)
Revista Medica del Hospital Colonia *(Mexico)*

Rev. Med. Hosp. Espan. (Mex.)
Revista Medica del Hospital Espanol *(Mexico)*

Rev. Med. Hosp. Obrero (Lima)
Revista Medica del Hospital Obrero (Lima) *(Peru)*

Rev. Med. Rio Grande do Sul
Revista de Medicina do Rio Grande do Sul *(Brazil)*

Rev. Med. Toulouse
*Revue de Medecine de Toulouse *(France)*

Rev. Med. Toulouse, Suppl.
*Revue de Medecine de Toulouse, Supplement *(France)*

Rev. Med. Valparaiso
Revista Medica de Valparaiso *(Chile)*

Rev. Met. (Madrid)
Revista de Metalurgia (Madrid) *(Spain)*

Rev. Met. (Paris)
*Revue de Metallurgie (Paris) *(France)*

Rev. Metal Lit.
*Review of Metal Literature *(U. S.)*

Rev. Mex. Cienc. Med. Biol.
Revista Mexicana de Ciencias Medicas y Biologicas *(Mexico)*

Rev. Mex. Cir. Ginecol. Cancer
Revista Mexicana de Cirugia, Ginecologia y Cancer *(Mexico)*

Rev. Mex. Fis.
*Revista Mexicana de Fisica *(Mexico)*

Rev. Mex. Tuberc. Aparato Resp.
Revista Mexicana de Tuberculosis y Aparato Respiratorio *(Mexico)*

Rev. Mod. Phys.
*Reviews of Modern Physics *(U. S.)*

Rev. Neurol. Buenos Aires
Revista Neurologica de Buenos Aires *(Argentina)*

Rev. Obstet. Ginecol. (Caracas)
Revista de Obstetricia y Ginecologia (Caracas) *(Venezuela)*

Rev. Opt.
Revue d'Optique, Theorique et Instrumentale *(France)*

Rev. Ortoped. Traumatol. Latinoamer.
Revista de Ortopedia y Traumatologia Latinoamericana *(Argentina)*

Rev. Otorrinolarincol. (Santiago, Chile)
Revista de Otorrinolaringologia (Santiago, Chile) *(Chile)*

Rev. Phys., Acad. Repub. Pop. Roum.
*Revue de Physique, Academie de la Republique Populaire Roumaine *(Romania)*

Rev. Phys. Appl., Suppl. J. Phys.
*Revue de Physique Appliquee (Supplement au Journal de Physique) *(France)*

Rev. Phys. Chem. Jap.
*Review of Physical Chemistry of Japan, The *(Japan)*

Rev. Port. Quim. (Lisbon)
*Revista Portuguesa de Quimica (Lisbon) *(Portugal)*

Rev. Psiquiat. (Santiago, Chile)
Revista de Psiquiatria (Santiago, Chile) *(Chile)*

Rev. Psiquiat. Peru.
Revista Psiquiatrica Peruana *(Peru)*

Rev. Pure Appl. Chem.
*Reviews of Pure and Applied Chemistry *(Australia)*

Rev. Quest. Sci.
Revue des Questions Scientifiques *(Belgium)*

Rev. Rhum.
Revue du Rhumatisme et des Maladies Osteo-Articulaires *(France)*

Rev. Roum. Biochim.
*Revue Roumaine de Biochimie *(Romania)*

Rev. Roum. Biol., Ser. Bot.
Revue Roumaine de Biologie, Serie Botanique *(Romania)*

Rev. Roum. Chim.
*Revue Roumaine de Chimie (continuation of Revue de Chimie, Academie de la Republique Populaire Roumaine) *(Romania)*

Rev. Roum. Endocrinol.
Revue Roumaine d'Endocrinologie *(Romania)*

Rev. Roum. Inframicrobiol.
Revue Roumaine d'Inframicrobiologie *(Romania)*

Rev. Roum. Med. Interne
Revue Roumaine de Medecine Interne *(Romania)*

Rev. Roum. Phys.
*Revue Roumaine de Physique *(Romania)*

Rev. Roum. Physiol.
*Revue Roumaine de Physiologie *(Romania)*

Rev. Roum. Sci. Tech., Ser. Electrotech. Energ.
Revue Roumaine des Sciences Techniques, Serie Electrotechnique et Energetique *(Romania)*

Rev. Sanit. Mil.
Revista Sanitara Militara *(Romania)*

Rev. Sci. Instrum.
*Review of Scientific Instruments, The *(U. S.)*

Rev. Soc. Argent. Biol.
Revista de la Sociedad Argentina de Biologia *(Argentina)*

Rev. Soc. Med.-Quir. Zulia
Revista de la Sociedad Medico-Quirurgica del Zulia *(Venezuela)*

Rev. Soc. Quim. Mex.
Revista de la Sociedad Quimica de Mexico *(Mexico)*

Rev. Suisse Zool.
Revue Suisse de Zoologie *(Switzerland)*

Rev. Surg.
Review of Surgery *(U. S.)*

Rev. Tuberc. (Paris)
Revue de la Tuberculose (Paris) *(France)*

Rev. Union Mat. Argent. Asoc. Fis. Argent.
*Revista de la Union Matematica Argentina y de la Asociacion Fisica Argentina *(Argentina)*

Rev. Univ. Ind. Santander
Revista de la Universidad Industrial de Santander *(Colombia)*

Rev. Univ. Madrid
Revista de la Universidad de Madrid *(Spain)*

Rev. Urol. (Caracas)
Revista de Urologia (Caracas) *(Venezuela)*

Rev. Urol. (Mex.)

Revista de Urologia *(Mexico)*

Rheumatism
Rheumatism *(England)*

Rhode Island Med. J.
Rhode Island Medical Journal, The *(U. S.)*

Rhumatologie
Rhumatologie *(France)*

Ric. Sci.
*Ricerca Scientifica, La (Supersedes Ricerca Scientifica, La. Parte 2 Rendiconti, Sezione A, Abiologica and Sezione B, Biologica) *(Italy)*

Ric. Sci. Rend., Sez. A
Ricerca Scientifica, La. Parte 2: Rendiconti, Sezione A, Abiologica *(Italy)*

Ric. Sci. Rend., Sez. B
Ricerca Scientifica, La. Parte 2: Rendiconti, Sezione B, Biologica *(Italy)*

Rika Gaku Kenkyusho Hokoku
*Rika Gaku Kenkyusho Hokoku (Reports of the Institute of Physical and Chemical Research) *(Japan)*

Rinsho Byori
*Rinsho Byori (Japanese Journal of Clinical Pathology) *(Japan)*

Rinsho Hoshasen
*Rinsho Hoshasen (Clinical Radiology) *(Japan)*

Riv. Biol.
Rivista di Biologia (Pubblicata a Cura dell'Istituto di Biologia Generale dell'Universita di Perugia) *(Italy)*

Riv. Clin. Pediat.
Rivista di Clinica Pediatrica *(Italy)*

Riv. Ing.
Rivista de Ingeneria *(Italy)*

Riv. Ing. Nucl.
*Rivista di Ingeneria Nucleare *(Italy)*

Riv. Ist. Sieroter. Ital.
Rivista dell'Istituto Sieroterapico Italiano *(Italy)*

Riv. Ital. Ig.
Rivista Italiana d'Igiene *(Italy)*

Riv. Ital. Stomatol.
Rivista Italiana di Stomatologia *(Italy)*

Riv. Med. Aeronaut.
Rivista di Medicina Aeronautica *(Italy)*

Riv. Med. Aeronaut. Spaz.
*Rivista di Medicina Aeronautica e Spaziale *(Italy)*

Riv. Meteorol. Aeronaut.
*Rivista di Meteorologia Aeronautica *(Italy)*

Rivoluzione Ind.
Rivoluzione Industriale *(Italy)*

Riv. Ostet. Ginecol.
Rivista di Ostetricia e Ginecologia *(Italy)*

Riv. Patol. Clin. Sperim.
Rivista di Patologia Clinica e Sperimentale *(Italy)*

Rocz. Chem.
*Roczniki Chemii *(Poland)*

Rocz. Nauk Roln., Ser. A
Roczniki Nauk Rolniczych, Seria A *(Poland)*

Rocz. Panstw. Zakladu Hig.
*Roczniki Panstwowego Zakladu Higieny *(Poland)*

Rocz. Technol. Chem. Zywnosci
Rocznik Technologii i Chemii Zywnosci *(Poland)*

Rodo Kagaku
Rodo Kagaku (The Journal of Science of Labor) *(Japan)*

Roentgen Bl.
Roentgen Blaetter *(Germany)*

Roentgenpraxis
Roentgenpraxis (continues in part Roentgen und Laboratoriums Praxis) *(West Germany)*

Rost Kristallov, Akad. Nauk SSSR, Inst. Kristallogr.
Rost Kristallov, Akademiya Nauk SSSR, Institut Kristallografii *(U.S.S.R.)*

Rozpr. Cesk. Akad. Ved, Rada Mat. Prir. Ved
Rozpravy Ceskoslovenske Akademie Ved, Rada Matematickych a Prirodnich Ved *(Czechoslovakia)*

Rozpr. Elektrotech.
*Rozprawy Elektrotechniczne *(Poland)*

Rozpr. Inz.
Rozprawy Inzynierskie *(Poland)*

Rubber Age (N. Y.)
*Rubber Age, The (New York) *(U. S.)*

Rubber Chem. Technol.
Rubber Chemistry and Technology *(U. S.)*

Rudy Metale Niezelazne
*Rudy i Metale Niezelazne *(Poland)*

Rum. Med. Rev.
Rumanian Medical Review *(Romania)*

Russ. Cast. Prod. (Engl. Transl.)
Russian Castings Production (English Translation of Liteinoe Proizvodstvo) *(England)*

Russ. Met. Mining (Engl. Transl.)
*Russian Metallurgy and Mining (English Translation of Izvestiya Akademii Nauk SSSR. Metallurgiya i Gornol Delo) *(England)*

Ryb. Khoz.
Rybnoe Khozyaistvo *(U.S.S.R.)*

SAE (Soc. Automotive Eng.) J.
*SAE (Society of Automotive Engineers) Journal *(U. S.)*

SAE (Soc. Automot. Eng.) Tech. Progr. Ser.
*SAE (Society of Automotive Engineers) Technical Progress Series *(U. S.)*

SAE (Soc. Automotive Eng.) Trans.
*SAE (Society of Automotive Engineers) Transactions *(U. S.)*

S. Afr. J. Agr. Sci.
South African Journal of Agricultural Science *(S. Africa)*

S. Afr. J. Obstet. Gynaecol.
South African Journal of Obstetrics and Gynaecology *(South Africa)*

S. Afr. J. Radiol.
South African Journal of Radiology *(S. Africa)*

S. Afr. Med. J.
South African Medical Journal *(South Africa)*

S. Afr. Mining Eng. J.
South African Mining and Engineering Journal *(South Africa)*

Sahko
*Sahko. Electricity in Finland *(Finland)*

Saiko To Hoan
*Saiko To Hoan (Mining and Safety) *(Japan)*

Saishin Igaku
*Saishin Igaku (Modern Medicine) *(Japan)*

Salud Publica Mex.
Salud Publica de Mexico *(Mexico)*

Sanfujinka no Shimpo
*Sanfujinka no Shimpo (Advances in Obstetrics and Gynaecology) *(Japan)*

Sangre
Sangre *(Spain)*

Sangyo Igaku
*Sangyo Igaku (Japanese Journal of Industrial Health) *(Japan)*

Sanshi Kagaku Kenkyusho Iho
Sanshi Kagaku Kenkyusho Iho (Reports of the Silk Science Research Institute) *(Japan)*

Santo Tomas J. Med.
Santo Tomas Journal of Medicine *(Philippines)*

San'yo Gijutsu Zasshi
San'yo Gijutsu Zasshi (Journal of the San'yo Association for Advancement of Science and Engineering) *(Japan)*

Sapporo Igaku Zasshi
Sapporo Igaku Zasshi (The Sapporo Medical Journal) *(Japan)*

Sapporo Med. J.
Sapporo Medical Journal, The
see Sapporo Igaku Zasshi

Sb. Lekar.
*Sbornik Lekarsky *(Czechoslovakia)*

Sb. Nauch. Tr. Inst. Metallofiz., Akad. Nauk Ukr. SSR
Sbornik Nauchnykh Trudov Instituta Metallofiziki, Akademiya Nauk Ukrainskoi SSR (formerly Sbornik Nauchnykh Rabot Instituta Metallofiziki, Akademiya Nauk Ukrainskoi SSR) *(Ukrainian S.S.R.)*

Sb. Nauch. Tr. Vses. Nauch.-Issled. Gorno-Met. Inst. Tsvet. Metal.
Sbornik Nauchnykh Trudov Vsesoyuznogo Nauchno-Issledovatel'skogo Gorno-Metallurgicheskogo Instituta Tsvetnykh Metallov *(U.S.S.R.)*

Sb. Tr., Mosk. Inzh.-Stroitel. Inst.
Sbornik Trudov, Moskovskii Inzherno-Stroitel'nyi Institut im. V. V. Kuibysheva *(U.S.S.R.)*

Sb. Tr. Tsent. Nauch.-Issled. Inst. Chern. Met.
Sbornik Trudov Tsentral'nogo Nauchno-Issledovatel'skogo Instituta Chernoi Metallurgii *(U.S.S.R.)*

Sb. Ved. Praci Lekar. Fak. Karlovy Univ. Hradci Kralove
*Sbornik Vedeckych Praci Lekarske Fakulty Karlovy University v Hradci Kralove *(Czechoslovakia)*

Sb. Vys. Sk. Zemed. Brne, Rada B
Sbornik Vysoke Skoly Zemedelske v Brne, Rada B *(Czechoslovakia)*

Scand. J. Clin. Lab. Invest.
*Scandinavian Journal of Clinical & Laboratory Investigation

(Denmark)

Scand. J. Haematol.
*Scandinavian Journal of Haematology *(Denmark)*

Scand. J. Psychol.
*Scandinavian Journal of Psychology *(Sweden)*

Scand. J. Resp. Dis.
*Scandinavian Journal of Respiratory Diseases (formerly Acta Tuberculosea et Pneumologica Scandinavica) *(Denmark)*

Scand. J. Resp. Dis., Suppl.
*Scandinavian Journal of Respiratory Diseases, Supplement (formerly Acta Tuberculosea et Pneumologica Scandinavica, Supplementum) *(Denmark)*

Schleif- Poliertech.
Schleif- und Poliertechnik *(Germany)*

Schriftenreihe Bundesmin. Wiss. Forsch., Forsch. Bild.
*Schriftenreihe des Bundesministers fuer Wissenschaftliche Forschung, Forschung und Bildung *(Germany)*

Schriftenreihe Bundesmin. Wiss. Forsch., Kernenergierecht
*Schriftenreihe des Bundesministers fuer Wissenschaftliche Forschung, Kernenergierecht (formerly Schriftenreihe des Bundesministers fuer Atomkernenergie und Wasserwirtschaft, Kernenergiericht) *(Germany)*

Schriftenreihe Bundesmin. Wiss. Forsch., Radionukl.
*Schriftenreihe des Bundesministers fuer Wissenschaftliche Forschung, Radionuklide *(Germany)*

Schriftenreihe Bundesmin. Wiss. Forsch., Strahlenschutz (Munich)
*Schriftenreihe des Bundesministers fuer Wissenschaftliche Forschung, Strahlenschutz (Munich) *(Germany)*

Schweissen Schneiden
Schweissen und Schneiden *(West Germany)*

Schweiz. Arch. Angew. Wiss. Tech.
*Schweizer Archiv fuer Angewandte Wissenschaft und Technik *(Switzerland)*

Schweiz. Med. Wochschr.
*Schweizerische Medizinische Wochenschrift *(Switzerland)*

Schweiz. Mineral. Petrog. Mitt.
Schweizerische Mineralogische und Petrographische Mitteilungen *(Switzerland)*

Sci. Amer.
*Scientific American *(U. S.)*

Sci. Basis Med.: Ann. Rev.
Scientific Basis of Medicine: Annual Reviews *(England)*

Sci. Citizen
Scientist and Citizen (formerly Nuclear Information) *(U. S.)*

Sci. Cult. (Calcutta)
*Science and Culture (Calcutta) *(India)*

Science
*Science *(U. S.)*

Science (Tokyo)
Science (Tokyo)
see Kagaku (Tokyo)

Scientia (Milan)
*Scientia (Milan) *(Italy)*

Scientia (Pekina)
Scientia (Pekina)
see K'o Hsueh T'ung Pao

Scientia (Valparaiso, Chile)
*Scientia (Valparaiso, Chile) *(Chile)*

Sci. Ind. Photogr.
Science et Industries Photographiques *(France)*

Sci. J.
*Science Journal *(England)*

Sci. Light (Tokyo)
Science of Light (Tokyo) *(Japan)*

Sci. Mech.
Science of Machine
see Kikai No Kenkyu

Sci. Pap. Col. Gen. Educ., Univ. Tokyo
*Scientific Papers of the College of General Education, University of Tokyo *(Japan)*

Sci. Pap. Inst. Phys. Chem. Res. (Tokyo)
*Scientific Papers of the Institute of Physical and Chemical Research (Tokyo) (formerly Journal of the Scientific Research Institute (Tokyo)) *(Japan)*

Sci. Progr. (London)
*Science Progress (London) *(England)*

Sci. Progr.-Nature
*Science Progres--La Nature *(France)*

Sci. Rep. Fac. Agr., Ibaraki Univ.
Scientific Reports of the Faculty of Agriculture, Ibaraki University
see Ibaraki Daigaku Nogakubu Gakujutsu Hokoku

Sci. Rep. Kanazawa Univ.
Science Reports of the Kanazawa University, The *(Japan)*

Sci. Rep. Res. Inst. Theoret. Phys., Hiroshima Univ.
*Scientific Reports of the Research Institute for Theoretical Physics, Hiroshima University *(Japan)*

Sci. Rep. Res. Inst., Tohoku Univ., Ser. A
*Scientific Reports of the Research Institutes, The, Tohoku University, Series A *(Japan)*

Sci. Rep. Saitama Univ., Ser. A
*Science Reports of Saitama University, The, Series A *(Japan)*

Sci. Rep. Tohoku Univ., First Ser.
Science Reports of the Tohoku University, First Series *(Japan)*

Sci. Rep. Tohoku Univ., Fifth Ser.
*Science Reports of the Tohoku University, Fifth Series: Geophysics *(Japan)*

Sci. Res.
*Scientific Research *(U. S.)*

Sci. Rev. (Manila)
*Science Review (Manila) *(Philippines)*

Sci. Sinica (Peking)
*Scientia Sinica (Pekina) (Chuna Kuo K'o Hsueh) *(China)*

Sci. Technol. Jap.
Science and Technology of Japan
see Nippon No Kagaku To Gijutsu

Sci. Terre
Sciences de la Terre *(France)*

Sci. World
Scientific World *(England)*

Scot. Med. J.
Scottish Medical Journal *(Scotland)*

Scripta Med. Fac. Med. Univ. Brun. Olomuc.
Scripta Medica Facultatum Medicinae Universitatum Brunensis et Olomucencis *(Czechoslovakia)*

Securitas
Securitas *(Italy)*

Seibutsu Butsuri
Seibutsu Butsuri (Journal of the Biophysical Society of Japan) *(Japan)*

Seigyo Kogaku
*Seigyo Kogaku (Journal of the Japan Association of Automatic Control Engineers) *(Japan)*

Seikagaku
*Seikagaku *(Japan)*

Seikei Geka
Seikei Geka (Orthopedic Surgery) *(Japan)*

Seiken Jiho
*Seiken Jiho (Reports of the Kihara Inst. for Biological Research) *(Japan)*

Seisan-Kenkyu
*Seisan-Kenkyu (Industrial Production Research) *(Japan)*

Seitetsu Kenkyu
Seitetsu Kenkyu (Yawata Technical Report) *(Japan)*

Sekiyu Gijutsu Kyokaishi
*Sekiyu Gijutsu Kyokaishi (Journal of the Japanese Association of Petroleum Technologists) *(Japan)*

Selek. Semenovod.
Selektsiya i Semenovodstvo *(U.S.S.R.)*

Sel'skokhoz. Biol.
Sel'skokhozyaistvennaya Biologiya (formerly Agrobiologiya) *(U.S.S.R.)*

Sem. Hop. Paris
Semaine des Hopitaux de Paris, La *(France)*

Semicond. Prod.
*Semiconductor Products *(U. S.)*

Sempaku
*Sempaku (Ship) *(Japan)*

Separation Sci.
*Separation Science *(U. S.)*

Setchaku
*Setchaku (Adhesion and Adhesives (Kyoto) *(Japan)*

Sheng Li Hsueh Pao
Sheng Li Hsueh Pao (Acta Biochimica Sinica) *(China)*

Sheng Wu Hua Hsueh Yu Shing Wu Wu Li Hsueh Pao
Sheng Wu Hua Hsueh Yu Shing Wu Wu Li Hsueh Pao (Acta Biochimica et Biophysica Sinica) *(China)*

Shigaku
Shigaku (Odontology (Tokyo)) *(Japan)*

Shih Yen Sheng Wu Hsueh Pao
Shih Yen Sheng Wu Hsueh Pao (Acta Biologiae Experimentalis Sinica) *(China)*

Shikoku Acta Med.

Shikoku Acta Medica
see **Shikoku Igaku Zasshi**

Shikoku Igaku Zasshi
Shikoku Igaku Zasshi (Shikoku Acta Medica) *(Japan)*

Shimane Daigaku Ronshu, Shizen Kagaku
*Shimane Daigaku Ronshu, Shizen Kagaku (Bulletin of the Shimane University, Natural Science) *(Japan)*

Shin Kinzoku Kogyo
*Shin Kinzoku Kogyo (Newer Metal Industry) *(Japan)*

Shinku
*Shinku (Journal of the Vacuum Society of Japan) *(Japan)*

Shinku Kagaku
*Shinku Kagaku (Vacuum Chemistry) *(Japan)*

Shinshu Igaku Zasshi
Shinshu Igaku Zasshi (The Shinshu Medical Journal) *(Japan)*

Shinshu Med. J.
Shinshu Medical Journal, The
see **Shinshu Igaku Zasshi**

Shinyaku To Rinsho
Shinyaku To Rinsho (New Remedies and Clinic) *(Japan)*

Ship
Ship
see **Sempaku**

Shitsuryo Bunseki
*Shitsuryo Bunseki (Mass Spectroscopy) *(Japan)*

Shizen
*Shizen (Nature) *(Japan)*

SIAM (Soc. Ind. Appl. Math.) J. Appl. Math.
*SIAM (Society for Industrial and Applied Mathematics) Journal on Applied Mathematics (formerly Journal of the Society for Industrial and Applied Mathematics) *(U. S.)*

SIAM (Soc. Ind. Appl. Math.) Rev.
*SIAM (Society for Industrial and Applied Mathematics) Review *(U. S.)*

Sibirsk. Mat. Zh.
Sibirskii Matematicheskii Zhurnal *(U.S.S.R.)*

Siemens Rev.
Siemens Review *(West Germany)*

Siemens-Z.
*Siemens-Zeitschrift *(West Germany)*

Silikat Tech.
Silikat Technik *(Germany)*

Silvae Genet.
Silvae Genetica *(West Germany)*

Sitzungsber. Ges. Befoerd. Ges. Naturwiss. Marburg
*Sitzungsberichte der Gesellschaft zur Befoerderung der Gesamten Naturwissenschaften zu Marburg *(Germany)*

Sky Telesc.
Sky and Telescope *(U. S.)*

S. Med. J.
Southern Medical Journal *(U. S.)*

Soc. Sci. Fenn., Comment. Phys.-Math.
Societas Scientiarum Fennica, Commentationes Physico-Mathematicae *(Finland)*

Soao Igaku
*Soao Igaku (Medicine) *(Japan)*

Sogo Rinsho
*Sogo Rinsho (Clinic All-Round) *(Japan)*

Sogo Shikensho Nempo
*Sogo Shikensho Nempo (Annual Report of the Engineering Research Institute, Univ. of Tokyo) *(Japan)*

Soil Sci.
*Soil Science *(U. S.)*

Soil Sci. Plant Nutr. (Tokyo)
Soil Science and Plant Nutrition (Tokyo) *(Japan)*

Soil Sci. Soc. Amer., Proc.
*Soil Science Society of America, Proceedings *(U. S.)*

Soils Fert.
Soils and Fertilizers *(England)*

Solar Energy
*Solar Energy *(U. S.)*

Solar Phys.
*Solar Physics. *(Netherlands)*

Solid State Commun.
Solid State Communications *(England–U. S.)*

Solid-State Electron.
*Solid-State Electronics *(U. S.)*

Solid State Phys.
*Solid State Physics *(U. S.)*

Solid State Phys. Chem.
Solid State Physics and Chemistry
see **Bussei**

Soobshch. Akad. Nauk Gruz. SSR
*Soobshcheniya Akademii Nauk Gruzinskoi SSR *(Georgian S.S.R.)*

Saryushiron Kenkyu
*Soryushiron Kenkyu (Study of Elementary Particles) *(Japan)*

Sosei To Kako
*Sosei To Kako (Journal of Japan Society for Technology of Plasticity) *(Japan)*

Soudage Tech. Connexes
Soudage et Techniques Connexes *(France)*

Southwestern Vet.
Southwestern Veterinarian, The *(U. S.)*

Sov. Astron.-AJ (Engl. Transl.)
*Soviet Astronomy–AJ (English Translation of Astronomicheskii Zhurnal) *(U. S.)*

Sov. J. Non-Ferrous Metals (Engl. Transl.)
Soviet Journal of Non-Ferrous Metals, The (English Translation of Tsvetnye Metally) *(U. S.)*

Sov. J. Nucl. Phys. (Engl. Transl.)
Soviet Journal of Nuclear Physics (English Translation of Yadernaya Fizika) *(U. S.)*

Sov. Phys.-Acoustics (Engl. Transl.)
*Soviet Physics-Acoustics (English Translation of Akusticheskii Zhurnal) *(U. S.)*

Sov. Phys.–Cryst. (Engl. Transl.)
*Soviet Physics–Crystallography (English Translation of Kristallografiya) *(U. S.)*

Sov. Phys.-Solid State (Engl. Transl.)
*Soviet Physics–Solid State (English translation of Fizika Tverdogo Tela) *(U. S.)*

Sov. Phys.-Tech. Phys. (Engl. Transl.)
Soviet Physics-Technical Physics (English Translation of Zhurnal Tekhnicheskoi Fiziki) *(U. S.)*

Sov. Phys.-Usp. (Engl. Transl.)
Soviet Physics-Uspekhi (English Translation of Uspekhi Fizicheskikh Nauk) *(U. S.)*

Sov. Plant Physiol. (Engl. Transl.)
Soviet Plant Physiology (English Translation of Fiziologiya Rastenii) *(U. S.)*

Sov. Powder Met. Metal Ceram. (Engl. Transl.)
Soviet Powder Metallurgy and Metal Ceramics (English Translation of Poroshkovaya Metallurgiya, Akademiya Nauk Ukrainskoi SSR) *(U. S.)*

Sov. Soil Sci. (Engl. Transl.)
Soviet Soil Science (English Translation of Pochvovedenie) *(U. S.)*

Space/Aeronaut.
*Space/Aeronautics *(U. S.)*

Spaceflight
*Spaceflight *(England)*

Space Sci. Rev.
*Space Science Reviews *(Netherlands)*

Spectrochim. Acta
Spectrochimica Acta *(England)*

Spectrochim. Acta, Part A
*Spectrochimica Acta, Part A. Molecular Spectroscopy *(England)*

Spectrochim. Acta, Part B
*Spectrochimica Acta, Part B. Atomic Spectroscopy *(England)*

Sperimentale
*Sperimentale, Lo *(Italy)*

Sprechsaal Keram. Glas Email Silikate
Sprechsaal fuer Keramik Glas Email Silikate *(West Germany)*

Staerke
Staerke, Die *(West Germany)*

Stahl Eisen
Stahl und Eisen *(West Germany)*

Stain Technol.
*Stain Technology *(U. S.)*

Stal
Stal *(U.S.S.R.)*

Stanki Instr.
Stanki i Instrument† *(U.S.S.R.)*

Staub
Staub *(Germany)*

Steam Heat. Eng.
Steam and Heating Engineer, The (incorporating The Steam Engineer, Heating and The Industrial Heating Engineer) *(England)*

Steel
Steel *(U. S.)*

Steklo Keram.

*Steklo i Keramika *(U.S.S.R.)*
Steroids
*Steroids. An International Journal *(U. S.)*
Stomatologiya
Stomatologiya *(U.S.S.R.)*
Strahlentherapie
*Strahlentherapie *(Germany)*
Strahlentherapie, Sonderboende
*Strahlentherapie, Sonderboende *(Germany)*
Stud. Biophys.
Studia Biophysica *(East Germany)*
Stud. Cercet. Astron.
*Studii si Cercetari de Astronomie *(Romania)*
Stud. Cercet. Biochim.
Studii si Cercetari de Biochimie (formerly Academia Republicii Populare Romine, Institutul de Biochemie, Studii si Cercetari de Biochimie *(Romania)*
Stud. Cercet. Biol., Ser. Zool.
Studii si Cercetari de Biologie, Seria Zoologie *(Romania)*
Stud. Cercet. Chim.
Studii si Cercetari de Chimie *(Romania)*
Stud. Cercet. Energ. Electrotch.
Studii si Cercetari de Energetica si Electrotehnica *(Romania)*
Stud. Cercet. Fiz.
*Studii si Cercetari de Fizica (formerly Academia Republicii Populare Romine, Institutul de Fizica Atomica si Institutul de Fizica, Studii si Cercetari de Fizica) *(Romania)*
Stud. Cercet. Fiziol.
*Studii si Cercetari de Fiziologie *(Romania)*
Stud. Cercet. Geol., Geofiz., Geogr., Ser. Geofiz.
Studii si Cercetari de Geologie, Geofizica, Geografie, Seria Geofizica *(Romania)*
Stud. Cercet. Inframicrobiol.
Studii si Cercetari de Inframicrobiologie *(Romania)*
Stud. Cercet. Mat.
Studii si Cercetari Matematice *(Romania)*
Stud. Cercet. Mec. Apl.
Studii si Cercetari de Mecanica Aplicata *(Romania)*
Stud. Cercet. Med. Interna
Studii si Cercetari de Medicina Interna *(Romania)*
Stud. Cosmic Ray
Studies of Cosmic Ray
see Uchusen Kenkyu
Stud. Geophys. Geod.
*Studia Geophysica et Geodaetica, Ceskoslovenska Akademie Ved *(Czechoslovakia)*
Stud. Math.
Studia Mathematica *(Poland)*
Stud. Med. Szeged.
*Studia Medica Szegedinensia *(Hungary)*
Stud. Sci. Math. Hung.
*Studia Scientiarum Mathematicarum Hungarica *(Hungary)*
Stud. Univ. Babes-Bolyai, Ser. Biol.
Studia Universitatis Babes-Bolyai, Series Biologia *(Romania)*
Stud. Univ. Babes-Bolyai, Ser. Chem.
*Studia Universitatis Babes-Bolyai, Series Chemia *(Romania)*
Stud. Univ. Babes-Bolyai, Ser. Math.-Phys.
*Studia Universitatis Babes-Bolyai, Series Mathematica-Physica *(Romania)*
Study Elem. Particles
Study of Elementary Particles
see Soryushiron Kenkyu
Sudostroenie
Sudostroenie *(U.S.S.R.)*
Suiyokaishi
Suiyokaishi (Transactions of the Mining and Metallurgical Alumni Association) *(Japan)*
Sulzer Tech. Rev. (Switz.)
*Sulzer Technical Review *(Switzerland)*
Sum. Art. Fr. Tech. Press
*Summaries of Articles from the French Technical Press *(France)*
Sumitomo Denki
*Sumitomo Denki (Sumitomo Electric Review) *(Japan)*
Sumitomo Elec. Rev.
Sumitomo Electric Review
see Sumitomo Denki
Sumitomo Elec. Tech. Rev.
*Sumitomo Electric Technical Review *(Japan)*
Sumitomo Keikinzoku Giho
*Sumitomo Keikinzoku Giho (Sumitomo Light Metals Technical Reports) *(Japan)*
Sumitomo Light Metals Tech. Rep.
Sumitomo Light Metals Technical Reports
see Sumitomo Keikinzoku Giho
Suomen Kem.
*Suomen Kemistilehti *(Finland)*
Surface Sci.
Surface Science *(Netherlands)*
Surg. Clin. N. Amer.
*Surgical Clinics of North America, The *(U. S.)*
Surgery
*Surgery *(U. S.)*
Surg. Forum
*Surgical Forum, (Proceedings of the Forum Sessions, Clinical Congress of the American College of Surgeons) *(U. S.)*
Surg., Gynecol. Obstet.
*Surgery, Gynecology and Obstetrics with International Abstracts of Surgery *(U. S.)*
Suvrem. Med.
Suvremenna Meditsina *(Bulgaria)*
Svarochn. Proizv.
*Svarochnoe Proizvodstvo *(U.S.S.R.)*
Svensk Kem. Tidskr.
*Svensk Kemisk Tidskrift *(Sweden)*
Symp. Soc. Gen. Microbiol.
Symposium of the Society for General Microbiology *(England)*
Ta Han Hua Hsueh Hui-Chih
Ta Han Hua Hsueh Hui-Chih (Journal of the Korean Chemical Society) *(Korea)*
Taiki Hoshano Kansoku Seiseki
*Taiki Hoshano Kansoku Seiseki (Bulletin of the Atmospheric Radioactivity) *(Japan)*
Talanta
*Talanta *(England)*
Tanso
*Tanso (Carbons) *(Japan)*
Tappi
Tappi *(U. S.)*
Tech. J. Water Purif.
Technical Journal of Water Purification
see Mizushori Gijutsu
Tech. Mitt. Krupp. Forschungsber.
*Technische Mitteilungen Krupp. Forschungsberichte *(Germany)*
Tech. Mod.
Technique Moderne; Revue Universelle des Sciences Appliquees a l'Industrie *(France)*
Technique (Muirhead)
*Technique (Muirhead). A Journal of Instrument Engineering *(U. S.)*
Technol. Rep. Kyushu Univ.
Technology Reports of the Kyushu University
see Kyushu Daigaku Kogaku Shuho
Technol. Rep. Osaka Univ.
*Technology Reports of the Osaka University *(Japan)*
Technol. Rep. Tohoku Univ.
*Technology Reports of the Tohoku University *(Japan)*
Technol. Week
Technology Week, including Missiles and Rockets *(U. S.)*
Technometrics
*Technometrics. A Journal of Statistics for the Physical, Chemical and Engineering Sciences *(U. S.)*
Tech. Pr.
Technicka Praca *(Czechoslovakia)*
Tech. Rep. Eng. Res. Inst., Kyoto Univ.
*Technical Reports of the Engineering Research Institute, Kyoto University *(Japan)*
Tectonophysics
Tectonophysics *(Netherlands)*
Tech. Rev., Mitsubishi Nippon Heavy-Ind.
Technical Review, Mitsubishi Neippon Heavy-Industries
see Mitsubishi Nippon Juko Giho
Tech. Sci. Aeronaut. Spatiales
Technique et Science Aeronautiques et Spatiales *(France)*
Tech. Ueberwach.
Technische Ueberwachung *(Germany)*
Tehnika (Belgrade)
Tehnika (Belgrade) *(Yugoslavia)*
Tek. Vetensk. Forsk.
Teknisk Vetenskaplig Forskning *(Sweden)*
Telecommun. J.

Telecommunication Journal *(Switzerland)*
Telecommun. Radio Eng. (USSR) (Engl. Transl.)
*Telecommunications and Radio Engineering (English Translation two journals: Elektrosvyaz and Radiotekhnika) *(U. S.)*
Telefunken Zeit.
*Telefunken Zeitung *(Germany)*
Tellus
*Tellus. A Quarterly Journal of Geophysics *(Sweden)*
Tenn. Farm Home Sci., Progr. Rep.
Tennessee Farm and Home Science, Progress Report *(U. S.)*
Teor. Eksp. Khim.
*Teoreticheskaya i Eksperimentalnaya Khimiya *(Ukrainian S.S.R.)*
Teor. Veroyat. Primen.
*Teoriya Veroyatnostei i ee Primeneniya *(U.S.S.R.)*
Teploenergetika
*Teploenergetika *(U.S.S.R.)*
Teplofiz. Vysok. Temp.
*Teplofizika Vysokikh Temperatur† *(U.S.S.R.)*
Terap. Arkh.
Terapevticheskii Arkhiv *(U.S.S.R.)*
Termotecnica (Milan)
*Termotecnica, La (Milan) *(Italy)*
Tetrahedron
*Tetrahedron *(Northern Ireland)*
Tetrahedron Lett.
*Tetrahedron Letters *(Northern Ireland)*
Tetsu To Hagane
Tetsu To Hagane (Journal of the Iron and Steel Institute) *(U. S.–Japan)*
Tex. J. Sci.
*Texas Journal of Science, The *(U. S.)*
Tex. Rep. Biol. Med.
*Texas Reports on Biology and Medicine *(U. S.)*
Tex. State J. Med.
Texas State Journal of Medicine *(U. S.)*
Textile Res. J.
*Textile Research Journal *(U. S.)*
Theor. Chim. Acta.
*Theoretica Chimica Acta *(Germany)*
Therapy (Tokyo)
Therapy *(Tokyo)*
see Chiryo
Therm. Power
Thermal Power, The
see Karyoku Hatsuden
Thorax
*Thorax *(England)*
Throm. Diath. Haemorrh.
*Thrombosis et Diathesis Haemorrhagica *(West Germany)*
Tidskr. Mil. Halsov.
Tidskrift i Militar Halsovard *(Sweden)*
Tidskr. Varme-, Vent.- Sanitetstek.
Tidskrift for Varme-, Ventilations- och Sanitetsteknik *(Sweden)*
Tidsskr. Kjemi, Bergv. Met.
Tidsskrift for Kjemi, Bergvesen og Metallurgi *(Norway)*
Tidsskr. Norske Laegforen.
Tidsskrift for den Norske Laegeforening *(Norway)*
Tidsskr. Planteavl
Tidsskrift for Planteavl *(Denmark)*
Tin Uses
Tin and Its Uses *(England)*
Today's Health
Today's Health *(U. S.)*
Toho Igakkai Zasshi
Toho Igakkai Zasshi (Journal of the Medical Society of Toho University) *(Japan)*
Tohoku Daigaku Dentsu Danwakai Kiroku
Tohoku Daigaku Dentsu Danwakai Kiroku (The Record of Electrical and Communication Engineering Conversation, Tohoku University) *(Japan)*
Tohoku J. Exp. Med.
*Tohoku Journal of Experimental Medicine, The *(Japan)*
Tohoku Kozan
*Tohoku Kozan (Journal of the Tohoku Mining Society) *(Japan)*
Tokai Daigaku Kiyo Kogakubu
*Tokai Daigaku Kiyo Kogakubu (Proceedings of the Faculty of Engineering of Tokai Univ. *(Japan)*
Tokai Denkyoku Giho
*Tokai Denkyoku Giho (Tokai Technological Journal) *(Japan)*
Tokai Technol. J.
Tokai Technological Journal
see Tokai Denkyoku Giho
Tokushima J. Exp. Med.
Tokushima Journal of Experimental Medicine, The *(Japan)*
Tokyo Daigaku Koku Kenkyusho Shuho
*Tokyo Daigaku Koku Kenkyusho Shusho (Bulletin of the Aeronautical Research Institute, University of Tokyo) *(Japan)*
Tokyo Ika Daigaku Zasshi
Tokyo Ika Daigaku Zasshi (The Journal of Tokyo Medical College) *(Japan)*
Tokyo Kogyo Daigaku Gakuho
*Tokyo Kogyo Daigaku Gakuho (Bulletin of the Tokyo Institute of Technology) *(Japan)*
Tokyo Kogyo Shikensho Hokoku
*Tokyo Kogyo Shikensho Hokoku (Reports of the Government Chemical Industrial Research Institute, Tokyo) *(Japan)*
Tokyo Metrop. Isotop. Center, Annu. Rep.
*Tokyo Metropolitan Isotope Center, Annual Report *(Japan)*
Tokyo Toritsu Kogyo Shoreikan Hokoku
*Tokyo-Toritsu Kogyo Shoreikan Hokoku (Reports of the Tokyo Metropolitan Industrial Research Institute) *(Japan)*
Tool Mfg. Eng.
Tool and Manufacturing Engineer, The *(U. S.)*
Torax
*Torax *(Uruguay)*
Toshiba Rebyu
Toshiba Rebyu (Toshiba Review) *(Japan)*
Toshiba Rev., Int. Ed.
*Toshiba Review, International Edition *(Japan)*
Toxicol. Appl. Pharmacol.
*Toxicology and Applied Pharmacology *(U. S.)*
Toxicon
*Toxicon *(U. S.–England)*
Trait. Therm.
Traitment Thermique *(France)*
Trans. AIME, Met. Soc.
Transactions of AIME, Metallurgical Society
see Trans. Met. Soc. AIME
Trans. Amer. Broncho-Esophagol. Ass.
Transactions of the American Broncho-Esophagological Association *(U. S.)*
Trans. Amer. Clin. Climatol. Ass.
Transactions of the American Clinical and Climatological Association *(U. S.)*
Trans. Amer. Fish. Soc.
Transactions of the American Fisheries Society *(U. S.)*
Trans. Amer. Geophys. Union
*Transactions of the American Geophysical Union *(U. S.)*
Trans. Amer. Laryngol., Rhinol. Otol. Soc.
Transactions of the American Laryngological, Rhinological and Otological Society, Inc. *(U. S.)*
Trans. Amer. Math. Soc.
*Transactions of the American Mathematical Society *(U. S.)*
Trans. Amer. Neurol. Ass.
Transactions of the American Neurological Association *(U. S.)*
Trans. Amer. Nucl. Soc.
*Transactions of the American Nuclear Society *(U. S.)*
Trans., Amer. Soc. Artif. Intern. Organs
Transactions, American Society for Artificial Internal Organs *(U. S.)*
Trans. Amer. Soc. Metals
Transactions of the American Society for Metals *(U. S.)*
Trans. Architect. Inst. Jap.
Transactions of the Architectural Institute of Japan
see Nippon Kenchiku Gakkai Ronbun Hokoku-Shu
Trans. ASAE (Amer. Soc. Agr. Eng.)
Transactions of the ASAE (American Society of Agricultural Engineers) *(U. S.)*
Trans. ASME (Amer. Soc. Mech. Eng.), Ser. A: J. Eng. Power
Transactions of the ASME (American Society of Mechanical Engineers), Series A: Journal of Engineering for Power
see J. Eng. Power
Trans. ASME (Amer. Soc. Mech. Eng.) Ser. B: J. Eng. Ind.
Transactions of the ASME (American Society of Mechanical Engineers), Series B. Journal of Engineering for Industry
see J. of Eng. Ind.
Trans. ASME (Amer. Soc. Mech. Eng.), Ser. C: J. Heat Transfer
Transactions of the ASME (American Society of Mechanical Engineers), Series C: Journal of Heat Transfer
see J. Heat Transfer
Trans. ASME (Amer. Soc. Mech. Eng.), Ser. D: J. Basic Eng.

Transactions of the ASME (American Society of Mechanical Engineers), Series D: Journal of Basic Engineering
see J. Basic Eng.

Trans. ASME (Amer. Soc. Mech. Eng.), Ser. E: J. Appl. Mech.
Transactions of the ASME (American Society of Mechanical Engineers), Series E: Journal of Applied Mechanics
see J. Appl. Mech.

Trans. ASME (Amer. Soc. Mech. Eng.), Ser. F. J. Lubric. Technol.
Transactions of the ASME (American Society of Mechanical Engineers), Series F. Journal of Lubrication Technology
see J. Lubric. Technol.

Trans. Bose Res. Inst. (Calcutta)
*Transactions of the Bose Research Institute (Calcutta) *(India)*

Trans. Brit. Bryol. Soc.
*Transactions of the British Bryological Society *(England)*

Trans. Brit. Ceram. Soc.
*Transactions of the British Ceramic Society incorporating British Ceramic Abstracts *(England)*

Trans. Can. Inst. Mining Met.
*Transactions of the Canadian Institute of Mining and Metallurgy and of the Mining Society of Nova Scotia *(Canada)*

Trans. Chalmers Univ. Technol., Gothenburg
*Transactions of Chalmers University of Technology, Gothenburg, Sweden *(Sweden)*

Trans. Eng. Inst. Can.
*Transactions of the Engineering Institute of Canada *(Canada)*

Trans. Faraday Soc.
*Transactions of the Faraday Society *(England)*

Transfusion
*Transfusion *(U. S.)*

Trans. Ill. State Acad. Sci.
Transactions of the Illinois State Academy of Science *(U. S.)*

Trans. Indian Inst. Metals
*Transactions of the Indian Instiute of Metals *(India)*

Trans. Inst. Chem. Eng. (London)
*Transactions of the Institution of Chemical Engineers (London) *(England)*

Trans. Inst. Mining Met.
Transactions of the Institution of Mining and Metallurgy (published with the Bulletin of the Institution of Mining and Metallurgy) *(England)*

Tr. Inst. Okeanol., Akad. Nauk SSSR
Trudy Instituta Okeanologii, Akademiya Nauk SSSR *(U.S.S.R.)*

Trans. Jap. Inst. Metals
*Transactions of the Japan Institute of Metals (Sendai) *(Japan)*

Trans. J. Plast. Inst.
*Transactions and Journal of the Plastics Institute *(England)*

Trans. Kans. Acad. Sci.
Transactions of the Kansas Academy of Science *(U. S.)*

Trans. Med. Soc. London
Transactions of the Medical Society of London *(England)*

Trans. Met. Soc. AIME
*Transactions of the Metallurgical Society of AIME (American Institute of Mining, Metallurgical, and Petroleum Engineers) *(U. S.)*

Trans. Mining Met. Alumni Ass.
Transactions of the Mining and Metallurgical Alumni Association
see Suiyokaishi

Trans. Nat. Res. Inst. Metals (Tokyo)
*Transactions of the National Research Institute for Metals (Tokyo) *(Japan)*

Trans. New Engl. Obstet. Gynecol. Soc.
Transactions of the New England Obstetrical and Gynecological Society *(U. S.)*

Trans. N. Y. Acad. Sci.
*Transactions of the New York Academy of Sciences *(U. S.)*

Trans. Ophthalmol. Soc. Aust.
Transactions of the Ophthalmological Society of Australia *(Australia)*

Trans. Ophthalmol. Soc. U. K.
Transactions of the Ophthalmological Society of the United Kingdom *(England)*

Transplantation
*Transplantation (formerly Transplantation Bulletin) *(U. S.)*

Trans. Proc. Geol. Soc. S. Afr.
Transactions and Proceedings of the Geological Society of South Africa *(South Africa)*

Trans. Roy. Inst. Technol., Stockholm
Transactions of the Royal Institute of Technology, Stockholm, Sweden *(Sweden)*

Trans. Roy. Soc. Can.
*Transactions of the Royal Society of Canada *(Canada)*

Trans. Roy. Soc. Trop. Med. Hyg.
*Transactions of the Royal Society of Tropical Medicine and Hygiene *(England)*

Trans. Soc. Instrum. Technol.
*Transactions of the Society of Instrument Technology *(England)*

Trend Eng. Univ. Wash.
*Trend in Engineering at the University of Washington *(U. S.)*

Tr. Energ. Inst., Akad. Nauk Azerb. SSR
*Trudy Energeticheskogo Instituta imeni I. G. Es'mana, Akademiya Nauk Azerbaidzhanskoi SSR *(Azerbaidzhan S.S.R.)*

Tr. Fiz. Inst., Akad. Nauk SSSR
*Trudy Fizicheskogo Institute imeni P. N. Lebedeva, Akademiya Nauk SSSR *(U.S.S.R.)*

Tr., Gos. Inst. Prikl. Khim.
Trudy, Gosudorstvennyi Institut Prikladnoi Khimii *(U.S.S.R.)*

Tr. Gruz. Politekh. Inst.
Trudy Gruzinskogo Politekhnicheskogo Instituta *(Georgian S.S.R.)*

Triangle. Sandoz J. Med. Sci.
Triangle. The Sandoz Journal of Medical Science *(Switzerland)*

Tr. Inst. Eksp. Klin. Onkol., Akad. Med. Nauk SSSR
Trudy Instituta Eksperimental'noi i Klinicheskoi Onkologii, Akademiya Meditsinskikh Nauk SSSR *(U.S.S.R.)*

Tr. Inst. Elektrokhim., Akad. Nauk SSSR, Ural. Filial
*Trudy Instituta Elektrokhimii, Akademiya Nauk SSSR, Ural'skii Filial† *(U.S.S.R.)*

Tr. Inst. Fiz., Akad. Nauk Azerb. SSR
*Trudy Instituta Fiziki, Akademii Nauk Azerbaidzhanskoi SSR *(Azerbaidzhan S.S.R.)*

Tr. Inst. Fiz., Akad. Nauk Gruz. SSR
*Trudy Instituta Fiziki, Akademii Nauk Gruzinskoi SSR *(Georgian S.S.R.)*

Tr. Inst. Fiz., Akad. Nauk Latv. SSR
Trudy Instituta Fiziki, Akademiya Nauk Latviiskoi SSR *(Latvian S.S.R.)*

Tr. Inst. Fiz. Astron., Akad. Nauk Est. SSR
*Trudy Instituta Fiziki i Astronomii, Akademiya Nauk Estonskoi SSR *(Estonian S.S.R.)*

Tr. Inst. Genet., Akad. Nauk SSSR
Trudy Instituta Genetiki, Akademiya Nauk SSSR *(U.S.S.R.)*

Tr. Inst. Geol. Nauk, Akad. Nauk Kaz. SSR
*Trudy Instituta Geologicheskikh Nauk, Akademiya Nauk Kazakhskoi SSR *(Kazakh S.S.R.)*

Tr. Inst. Met. im. A. A. Baikova, Akad. Nauk SSSR
Trudy Instituta Metallurgii imeni A. A. Baikova, Akademiya Nauk SSSR *(U.S.S.R.)*

Tr. Inst. Yadern. Fiz., Akad. Nauk Kaz. SSR
*Trudy Instituta Yadernoi Fiziki, Akademiya Nauk Kazakhskoi SSR *(Kazakh S.S.R.)*

Tr. Leningr. Politekh. Inst.
Trudy Leningradskogo Politekhnicheskogo Instituta imeni M. I. Kalinina *(U.S.S.R.)*

Tr. Mosk. Energ. Inst.
Trudy Moskovskogo Energeticheskogo Instituta *(U.S.S.R.)*

Tr. Mosk. Khim.-Tekhnol. Inst.
Trudy Moskovskogo Khimiko-Tekhnologicheskogo Instituta imeni D. I. Mendeleeva *(U.S.S.R.)*

Tr. Mosk. Obshchest. Ispyt. Prir., Otd. Biol.
Trudy Moskovskogo Obshchestva Ispytatelei Prirody, Otdel Biologicheskii *(U.S.S.R.)*

Tr. Nauch.-Tekh. Konf. Leningrad. Elek.-Tekh. Inst. Svyazi
Trudy Nauchno-Tekhnicheskoi Konferentsii Leningradskogo Elektro-Tekhnicheskogo Instituta Svyazi *(U.S.S.R.)*

Trop. Geogr. Med.
*Tropical and Geographical Medicine *(Netherlands)*

Tr. Shemakhinsk. Astrofiz. Observ., Akad. Nauk Azerb. SSR
*Trudy Shemakhinskoi Astrofizicheskoi Observatorii, Akademiya Nauk Azerbaidzhanskoi SSR *(Azerbaidzhan S.S.R.)*

Tr. Tomsk. Gos. Univ., Ser. Khim.
Trudy Tomskogo Gosudarstvennogo Universiteta imeni V. V. Kuibysheva, Seriya Khimicheskaya *(U.S.S.R.)*

Tr. Tsent. Inst. Prognozov
Trudy Tsentral'nogo Instituta Prognozov *(U.S.S.R.)*

Tr. Tsent. Nauch.-Issled. Proekt.-Konstr. Kotloturbinnogo Inst.
Trudy Tsentral'nogo Nauchno-Issledovatel'skogo i Proektno-Konstruktorskogo Kotloturbinnogo Instituta *(U.S.S.R.)*

Tr. Ural. Politekh. Inst.
Trudy Ural'skogo Politekhnicheskogo Instituta imeni

S. M. Kirova *(U.S.S.R.)*

Tr. Vses. Nauch.-Issled. Inst. Morsk. Ryb. Khoz. Okeanogr.
Trudy Vsesoyuznogo Nauchno-Issledovatel'skogo Instituta Morskogo Rybnogo Khozyaistva i Okeanografii *(U.S.S.R.)*

Tsitologiya
*Tsitologiya *(U.S.S.R.)*

Tsvetn. Metal.
*Tsvetnye Metally† *(U.S.S.R.)*

Tumori
*Tumori *(Italy)*

Tung Wu Hsueh Pao
Tung Wu Hsueh Pao (Acta Zoologica Sinica) *(China)*

Turk Tip Cem. Mecmuasi
Turk Tip Cemiyeti Mecmuasi *(Turkey)*

Turrialba
Turrialba *(Costa Rica)*

TVF (Tek. Vetenskaplig Forsk.)
TVF (Teknisk-Vetenskaplig Forskning) *(Sweden)*

Tydskr. Natuurwetensk.
*Tydskrif vir Natuurwetenskappe *(South Africa)*

Tzu Tung Hua Hsueh Pao
Tzu Tung Hua Hsueh Pao (Acta Automatica Sinica) *(China)*

Uchusen-Kenkyu
*Uchusen Kenkyu (Studies of Cosmic Ray) *(Japan)*

Uch. Zap. Leningrad. Gos. Univ., Ser. Fiz. Geol. Nauk
*Uchenye Zapiski Leningradskogo Gosudarstvennogo Universiteta imeni A. A. Zhdanova, Seriya Fizicheskikh i Geologicheskikh Nauk *(U.S.S.R.)*

Uch. Zap. Leningrad. Gos. Univ., Ser. Mat. Nauk
*Uchenye Zapiski Leningradskogo Gosudarstvennogo Universiteta imeni A. A. Zhdanova, Seriya Matematicheskikh Nauk *(U.S.S.R.)*

Uch. Zap. Mosk. Obl. Pedagog. Inst.
Uchenye Zapiski Moskovskogo Oblastnogo Pedagogicheskogo Instituta *(U.S.S.R.)*

Uch. Zap. Tartu. Gos. Univ.
*Uchenye Zapiski Tartuskogo Gosudarstvennogo Universiteta *(Estonian S.S.R.)*

Uch. Zap. Ul'yanovsk. Gos. Pedagog. Inst.
Uchenye Zapiski Ul'yanovskogo Gosudarstvennogo Pedagogicheskogo Instituta *(U.S.S.R.)*

Ukr. Biokhim. Zh.
*Ukrainskii Biokhimichnii Zhurnal *(Ukrainian S.S.R.)*

Ukr. Bot. Zh.
Ukrain'skii Botanichnii Zhurnal *(Ukrainian S.S.R.)*

Ukr. Fiz. Zh.
*Ukrainskii Fizicheskii Zhurnal *(Ukrainian S.S.R.)*

Ukr. Khim. Zh.
*Ukrainskii Khimicheskii Zhurnal *(Ukrainian S.S.R.)*

Ukr. Mat. Zh.
*Ukrainskii Matematicheskii Zhurnal *(Ukrainian S.S.R.)*

Ulster Med. J.
Ulster Medical Journal *(Northern Ireland)*

Ultrasonics
Ultrasonics *(England)*

Umsch. Wiss. Tech.
Umschau ueber die Fortschritte in Wissenschaft und Technik, Die *(Germany)*

Umweltradioakt. Strahlenbelast.
Umweltradioaktivitaet und Strahlenbelastung *(Germany)*

Unidia (Bogota)
Unidia (Bogota) *(Colombia)*

Union Med. Can.
*Union Medicale du Canada, L' *(Canada)*

Univ. Brux., Inst. Phys., Bull.
*Universite de Bruxelles, Institut de Physique, Bulletin *(Belgium)*

Univ. Nac. Litoral, Fac. Cienc. Mat., Fis.-Quim. Nat. Apl. Ind., Inst. Fisiogr. Geol., Pub.
*Universidad Nacional del Litoral, Facultad de Ciencias Matematicas, Fisico-Quimicas y Naturales Aplicadas a la Industria, Instituto de Fisiografia y Geologia, Publicaciones *(Argentina)*

Univ. Roorkee Res. J.
University of Roorkee Research Journal *(India)*

Univ. Toronto Med. J.
University of Toronto Medical Journal *(Canada)*

Urania (Krakow)
*Urania (Krakow) *(Poland)*

Urol. Int.
*Urologia Internationalis *(Switzerland)*

Urologe
Urologe *(Germany)*

U. S., Geol. Surv., Bull.
United States Department of the Interior, Geological Survey, Bulletins *(U. S.)*

U. S., Geol. Surv., Prof. Pap.
United States Department of the Interior, Geological Survey, Professional Paper *(U. S.)*

Usp. Fiz. Nauk
*Uspekhi Fizicheskikh Nauk† *(U.S.S.R.)*

Usp. Khim.
*Uspekhi Khimii† *(U.S.S.R.)*

Usp. Mat. Nauk
Uspekhi Matematicheskikh Nauk *(U.S.S.R.)*

Usp. Sovrem. Biol.
Uspekhi Sovremennoi Biologii *(U.S.S.R.)*

Utah Acad. Sci., Proc.
Utah Academy of Sciences, Arts and Letters, Proceedings *(U. S.)*

Uzbek. Khim. Zh.
Uzbekskii Khimicheskii Zhurnal, Akademiya Nauk Uzbekskoi SSR *(Uzbek S.S.R.)*

Uz. Biol. Zh.
*Uzbekskii Biologicheskii Zhurnal, Akademiya Nauk Uzbekskoi SSR *(Uzbek S.S.R.)*

Vacuum
*Vacuum *(U. S.)*

Vakuum-Tech.
*Vakuum-Technik *(Germany)*

Vascular Dis.
Vascular Diseases *(U. S.)*

Vazduhoplovni Glas.
Vazduhoplovni Glasnik *(Yugoslavia)*

VDI (Ver. Deut. Ing.) Z.
*VDI (Verein Deutscher Ingenieure) Zeitschrift *(Germany)*

Vector (Baltimore)
Vector (Baltimore) *(U. S.)*

Verh. Deut. Ges. Inn. Med.
Verhandlungen der Deutschen Gesellschaft fuer Innere Medizin *(Germany)*

Verh. Deut. Ges. Kreislaufforsch.
Verhandlungen der Deutschen Gesellschaft fuer Kreislaufforschung *(West Germany)*

Verh. Deut. Ges. Pathol.
Verhandlungen der Deutschen Gesellschaft fuer Pathologie *(Germany)*

Verh. Kon. Ned. Akad. Wetensch. Afd. Natuurk., Sect. I
*Verhandelingen der Koninklijke Nederlandse Akademie van Wetenschappen, Afdeling Natuurkunde, Section I *(Netherlands)*

Verh. Kon. Ned. Akad. Wetensch. Afd. Natuurk., Sect. II
*Verhandelingen der Koninklijke Nederlandse Akademie van Wetenschappen, Afdeling Natuurkunde, Section II *(Netherlands)*

Verh. Kon. Vlaam. Acad. Geneesk. Belg.
Verhandelingen van de Koninklijke Vlaamse Academie voor Geneeskunde van Belgie *(Belgium)*

Verres Refract.
Verres et Refractaires *(France)*

Vestn. Akad. Med. Nauk SSSR
Vestnik Akademii Meditsinskikh Nauk SSSR *(U.S.S.R.)*

Vestn. Akad. Nauk Kaz. SSR
*Vestnik Akademii Nauk Kazakhskoi SSR *(Kazakh S.S.R.)*

Vestn. Akad. Nauk SSSR
*Vestnik Akademii Nauk SSSR *(U.S.S.R.)*

Vestn. Cesk. Akad. Ved
*Vestnik Ceskoslovenske Akademie Ved *(Czechoslovakia)*

Vestn. Khir.
Vestnik Khirurgii imeni I. I. Grekova *(U.S.S.R.)*

Vestn. Leningr. Univ., Ser. Fiz. Khim
*Vestnik Leningradskogo Universiteta, Seriya Fiziki i Khimii *(U.S.S.R.)*

Vestn. Leningr. Univ., Ser. Geol. Geogr.
*Vestnik Leningradskogo Universiteta, Seriya Geologii i Geografii *(U.S.S.R.)*

Vestn. Leningr. Univ., Ser. Mat., Mekhan. Astron.
*Vestnik Leningradskogo Universiteta, Seriya Matematiki, Mekhaniki i Astronomii *(U.S.S.R.)*

Vestn. Moskov. Univ., Ser. II: Khim.
*Vestnik Moskovskogo Universiteta, Seriya II: Khimiya (formerly a part of Vestnik Moskovskogo Universiteta, Seriya Matematiki, Mekhaniki, Astronomii, Fiziki i Khimii) *(U.S.S.R.)*

Vestn. Moskov. Univ., Ser. III: Fiz. Astron.
*Vestnik Moskovskogo Universiteta, Seriya III. Fiziki, Astronomii *(U.S.S.R.)*

Vestn. Oftal'mol.
Vestnik Oftal'mologii *(U.S.S.R.)*

Vestn. Otorino-Laringol.
Vestnik Otorino-Laringologii *(U.S.S.R.)*

Vestn. Rentgenol. Radiol.
Vestnik Rentgenologii i Radiologii *(U.S.S.R.)*

Vestn. Slov. Kem. Drus.
*Vestnik Slovenskega Kemijskega Drustva *(Yugoslavia)*

Vestsi Akad. Navuk BSSR, Ser. Biyal. Navuk
*Vestsi Akademii Navuk BSSR, Seryya Biyalagichnykh Nvuk (formerly carried as Vestsi Akademii Navuk Belaruskai SSR, Seryya Biyalagichnykh Navuk) *(Belorussian S.S.R.)*

Vestsi Akad. Navuk BSSR, Ser. Fiz.-Tekh. Novuk
*Vestsi Akademii Navuk BSSR, Seriya Fizika-Tekhnichnykh Navuk *(Belorussian S.S.R.)*

Veterinariya
Veterinariya *(U.S.S.R.)*

Vet. Glas.
Veterinarski Glasnik *(Yugoslavia)*

Vet. Med. (Prague)
*Veterinari Medicina (Prague) *(Czechoslovakia)*

Vet. Rec.
*Veterinary Record, The *(England)*

Vet. Sb.
Veterinarna Sbirka *(Bulgaria)*

Vide
*Vide, Le, Technique-Applications *(France)*

Vierde Macht
Vierde Macht, De *(Netherlands)*

Vierteljahresber. Umweltradioaktiv. Strahlenbelast.
*Vierteljahresberichte Umweltradioaktivitaet Strahlenbelastung *(Germany)*

Vierteljahresschr. Naturforsch. Ges. Zuerich
Vierteljahresschrift der Naturforschenden Gesellschaft in Zuerich *(Switzerland)*

Vierteljahresschr. Schweiz. Sanitaetsoffiz.
Vierteljahrsschrift fuer Schweizerische Sanitaetsoffiziere *(Switzerland)*

Viinana Parishad Anusandhan Patrika
*Viinana Parishad Anusandhan Patrika *(India)*

Virchows Arch. Pathol. Anat. Physiol. Klin. Med.
Virchows Archiv fuer Pathologische Anatomie und Physiologie und fuer Klinische Medizin
see Arch. Pathol. Anat.

Virology
*Virology *(U. S.)*

Vision Res.
*Vision Research *(England–U. S.)*

Visn. Sil'skogospodar. Nauki
Visnik Sil'skogospodars'koi Nauki *(Ukrainian S.S.R.)*

Vitalst. Zivilisationskr.
Vitalstoffe Zivilisationskrankheiten *(West Germany)*

Vitamins (Kyoto)
Vitamins (Kyoto)
see Bitamin

Voedina
Voedina *(Netherlands)*

Voenno Med. Delo
Voenno Meditsinsko Delo *(Bulgaria)*

Voenno-Med. Zh.
*Voenno-Meditsinskii Zhurnal *(U.S.S.R.)*

Voen. Vestn.
Voennyi Vestnik *(U.S.S.R.)*

Vol. Zdravot. Listy
Volenske Zdravotnicke Listy *(Czechoslovakia)*

Vom Wasser
Vom Wasser *(Germany)*

Vop. Dozimetr. Zashch. Izluch., Moskov. Inzh. Fiz. Inst., Sb. Statei
*Voprosy Dozimetrii i Zashchity ot Izluchenii, Moskovskii Inzhenerno-Fizicheskii Institut, Sbornik Statei *(U.S.S.R.)*

Vop. Fiziol., Akad. Nauk Azerbaidzh. SSR, Sektor Fiziol.
*Voprosy Fiziologii, Akademiya Nauk Azerbaidzhanskoi SSR, Sektor Fiziologii *(Azerbaidzhan S.S.R.)*

Vop. Magn. Gidrodin., Akad. Nauk Latv. SSR, Inst. Fiz.
Voprosy Magnitnoi Gidrodinamiki, Akademiya Nauk Latviiskoi SSR, Institut Fiziki *(Latvian S.S.R.)*

Vop. Med. Khim.
*Voprosy Meditsinskoi Khimii *(U.S.S.R.)*

Vop. Neirokhir.
Voprosy Neirokhirurgii *(U.S.S.R.)*

Vop. Onkol.
*Voprosy Onkologii *(U.S.S.R.)*

Vop. Pitan.
Voprosy Pitaniya *(U.S.S.R.)*

Vop. Radiobiol., Sb. Tr.
*Voprosy Radiobiologii, Sbornik Trudov *(Armenian S.S.R.)*

Vop. Rud. Geofiz., Gos. Geol. Kom. SSSR
Voprosy Rudnoi Geofiziki, Gosudarstvennyi Geologisheskii Komitet SSSR (formerly Voprosy Rudnoi Geofiziki, Ministerstvo Geologii i Okhrany Nedr SSSR) *(U.S.S.R.)*

Vop. Rud. Geofiz., Min. Geol. Okhrany Nedr SSSR
Voprosy Rudnoi Geofiziki, Ministerstvo Geologii i Okhrany Nedr SSSR *(U.S.S.R.)*

Vop. Virusol.
*Voprosy Virusologii *(U.S.S.R.)*

Vox Sang.
*Vox Sanguinis *(Switzerland)*

Vrach. Delo
Vrachebnoe Delo *(Ukrainian S.S.R.)*

Vynalezy
Vynalezy *(Czechoslovakia)*

Vysokomol. Soedin.
Vysokomolekulyarnye Soedineniya† *(U.S.S.R.)*

Vysokomol. Soedin., Ser. A
*Vysokomolekulyarnye Soedineniya, Seriya A (continues in part Vysokomolekulyarnye Soedineniya) *(U.S.S.R.)*

Vysokomol. Soedin., Ser. B.
*Vysokomolekulyarnye Soedineniya, Seriya B. Kratkie Soobshcheniya (continues in part Vysokomolekulyarnye Soedineniya) *(U.S.S.R.)*

Wakayama Med. Rep.
Wakayama Medical Reports *(Japan)*

Waseda Daigaku Rikogaku Kenkyusho Hokoku
*Waseda Daigaku Rikogaku Kenkyusho Hokoku (Bulletin of the Scientific and Engineering Research Laboratory, Waseda University) *(Japan)*

Wasser, Luft Betrieb
Wasser, Luft und Betrieb *(Germany)*

Wasserwirtschaft
Wasserwirtschaft, Die *(West Germany)*

Water Resour. Res.
Water Resources Research *(U. S.)*

Water Sewage Works
Water & Sewage Works *(U. S.)*

Weatherwise
Weatherwise *(U. S.)*

Wei Sheng Wu Hsueh Pao
Wei Sheng Wu Hsueh Pao (Acta Microbiologica Sinica) *(China)*

Weld. Design Fabr.
Welding Design and Fabrication *(U. S.)*

Weld. J. (N. Y.)
*Welding Journal, The (New York) *(U. S.)*

Weld. Metal. Fabr.
Welding and Metal Fabrication (formerly Welding) *(England)*

Weld. Prod. (USSR) (Engl. Transl.)
Welding Production (USSR) (English Translation of Svarochnoe Proizvodstvo) *(England)*

Weld. Tech.
Welding Technique
see Yosetsu Gijutsu

Werkstattstechnik
Werkstattstechnik *(West Germany)*

Werkst. Korros.
Werkstoffe und Korrosion *(West Germany)*

West Indian Med. J.
West Indian Medical Journal, The *(Jamaica)*

Westinghouse Eng.
Westinghouse Engineer *(U. S.)*

West. Mach. Steel World
Western Machinery and Steel World *(U. S.)*

Wetter Leben
Wetter und Leben *(Austria)*

Wheat Inform. Serv. (Jap.)
Wheat Information Service *(Japan)*

Wiad. Chem.
*Wiadomosci Chemiczne *(Poland)*

Wien. Klin. Wochensch.
Wiener Klinische Wochenschrift *(Austria)*

Wien. Med. Wochensch.
Wiener Medizinische Wochenschrift *(Austria)*

Wien. Tieraerztl. Monatsschr.
Wiener Tieraerztliche Monatsschrift *(Austria)*
Wien. Z. Nervenheilk. Grenz.
Wiener Zeitschrift fuer Nervenheilkunde und deren Grenzgebiete *(Austria)*
Wireless World
*Wireless World; Electronics, Radio, Television *(England)*
Wire Wire Prod.
Wire and Wire Products *(U. S.)*
Wiss. Z. Friedrich-Schiller-Univ., Jena, Math.-Naturwiss. Reihe
Wissenschaftliche Zeitschrift der Friedrich-Schiller-Universitaet, Jena, Mathematisch-Naturwissenschaftliche Reihe *(Germany)*
Wiss. Z. Humboldt-Univ. Berlin, Math.-Naturwiss. Reihe
Wissenschaftliche Zeitschrift der Humboldt-Universitaet zu Berlin, Mathematisch-Naturwissenschaftliche Reihe *(Germany)*
Wiss. Z. Karl-Marx-Univ., Leipzig, Math.-Naturwiss. Reihe
Wissenschaftliche Zeitschrift der Karl-Marx-Universitaet, Leipzig. Mathematish-Naturwissenschaftliche Reihe *(East Germany)*
Wiss. Z. Tech. Hochsch. Otto Guericke Magdeburg
Wissenschaftliche Zeitschrift der Technischen Hochschule Otto von Guericke Magdeburg *(East Germany)*
Wiss. Z. Tech. Univ. Dresden
Wissenschaftliche Zeitschrift der Technischen Universitaet Dresden (formerly Wissenschaftliche Zeitschrift der Technischen Hochschule Dresden) *(Germany)*
World Health Organ. Chron.
*World Health Organization Chronicle *(Switzerland)*
World Health Organ., Tech. Rep. Ser.
World Health Organization, Technical Report Series *(U. S.)*
World's Poultry Sci. J.
World's Poultry Science Journal *(U. S.)*
Wu Li Hsueh Pao
Wu Li Hsueh Pao (Acta Physica Sinica) *(China)*
W. Va., Univ. Agr. Exp. Sta., Bull.
West Virginia, University Agricultural Experiment Station, Bulletin *(U. S.)*
WZE, Wiss. Z. Elektrotech.
WZE, Wissenschaftliche Zeitschrift der Elektrotechnik *(East Germany)*
Yadern. Fiz.
*Yadernaya Fizika† *(U.S.S.R.)*
Yakugaku Zasshi
*Yakugaku Zasshi (Journal of the Pharmaceutical Society of Japan) *(Japan)*
Yale J. Biol. Med.
*Yale Journal of Biology and Medicine, The *(U. S.)*
Yamanashi Daigaku Gakugeigakubu Kenkyu Hokoku
*Yamanashi Daigaku Gakugeigakubu Kenkyu Hokoku (Memoirs of the Faculty of Liberal Arts and Education, Yamanashi University) *(Japan)*
Yao Hsueh Hsueh Pao
Yao Hsueh Hsueh Pao (Acta Pharmaceutica Sinica) *(China)*
Yawata Tech. Rep.
Yawata Technical Report
see **Seitetsu Kenkyu**
Year Book Nucl. Med.
Year Book of Nuclear Medicine, The *(U. S.)*
Yogyo Kyokai Shi
*Yogyo Kyokai Shi (Journal of the Ceramic Association of Japan) *(Japan)*
Yokogawa Giho
*Yokogawa Giho (Yokogawa Technical Report) *(Japan)*
Yokogawa Tech. Rep.
Yokogawa Technical Report
see **Yokogawa Giho**
Yokohama Med. Bull.
*Yokohama Medical Bulletin *(Japan)*
Yonago Acta Med.
*Yonago Acta Medica *(Japan)*
Yonago Igaku Zasshi
Yonago Igaku Zasshi (The Journal of the Yonago Medical Association) *(Japan)*
Yonsei Med. J.
Yonsei Medical Journal *(Korea)*
Yosetsu Gakkaishi
*Yosetsu Gakkaishi (Journal of the Japan Welding Society) *(Japan)*
Yosetsu Gijutsu
*Yosetsu Gijutsu (Welding Technique) *(Japan)*
Yosui To Haisui
*Yosui To Haisui (Journal of Water and Waste) *(Japan)*
Yukagaku
Yukagaku (Journal of Japan Oil Chemists' Society) *(Japan)*
Yuki Gosei Kagaku Kyokai Shi
*Yuki Gosei Kagaku Kyokai Shi (Journal of the Society of Organic Synthetic Chemistry *(Japan)*
Zacchia
Zacchia *(Italy)*
Z. Aerztl. Fortbild.
Zeitschrift fuer Aertzliche Fortbildung *(East Germany)*
Zahnaerztl. Mitt.
Zahnaerztliche Mitteilungen *(West Germany)*
Zairyo
*Zairyo (Journal of the Japan Society for Materials) *(Japan)*
Z. Allg. Mikrobiol.
*Zeitschrift fuer Allgemeine Mikrobiologie, Morphologie, Physiologie, und Oekologie der Mikroorganismen *(Germany)*
Z. Alternsforsch.
Zeitschrift fuer Alternsforschung *(Germany)*
Z. Anal. Chem.
*Zeitschrift fuer Analytische Chemie, Fresenius' *(Germany)*
Z. Angew. Geol.
*Zeitschrift fuer Angewandte Geologie *(Germany)*
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*Zeitschrift fuer Angewandte Mathematik und Mechanik *(Germany)*
Z. Angew. Math. Phys.
*Zeitschrift fuer Angewandte Mathematik und Physik *(Switzerland)*
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*Zeitschrift fuer Angewandte Physik *(Germany)*
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*Zeitschrift fuer Anorganische und Allgemeine Chemie *(Germany)*
Zashchita Metal.
*Zashchita Metallov *(U.S.S.R.)*
Zastosowania Mat.
*Zastosowania Matematyki *(Poland)*
Z. Astrophys.
*Zeitschrift fuer Astrophysik *(Germany)*
Zavodsk. Lab.
*Zavodskaya Laboratoriya† *(U.S.S.R.)*
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*Zeitschrift fuer Biologie *(Germany)*
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*Zeitschrift fuer Chemie *(Germany)*
Zdravookhr. Beloruss.
Zdravookhranenie Belorussii *(Belorussian S.S.R.)*
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Zdravookhranenie Kazakhstana *(Kazakh S.S.R.)*
Zdrav. Tech. Vzduchotech.
Zdravotni Technika a Vzduchotechnika *(Czechoslovakia)*
Z. Elektrochem.
Zeitschrift fuer Elektrochemie *(West Germany)*
Zentralbl. Allgem. Pathol. Pathol. Anat.
Zentralblatt fuer Allgemeine Pathologie und Pathologische Anatomie *(Germany)*
Zentralbl. Arbeitsmed. Arbeitsschutz
Zentralblatt fuer Arbeitsmedizin und Arbeitsschutz *(Germany)*
Zentralbl. Bakteriol., Parasitenk., Abt. I. Orig.
*Zentralblatt fuer Bakteriologie, Parasitenkunde, Infektionskrankheiten und Hygiene, Abteilung I. Originale *(Germany)*
Zentralbl. Biol. Aerosol Forsch.
*Zentralblatt fuer Biologische Aerosol Forschung *(Germany)*
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Zentralblatt fuer Chirurgie *(Germany)*
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Zentralblatt fuer Gynaekologie *(Germany)*
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Zentralblatt fuer Veterinaermedizin *(Germany)*
Zentralbl. Veterinaermed., Reihe A
*Zentralblatt fuer Veterinaermedizin, Reihe A *(West Germany)*
Zentralbl. Veterinaermed., Reihe B
*Zentralblatt fuer Veterinaermedizin, Reihe B *(West Germany)*
Z. Ernaehrungswiss.
*Zeitschrift fuer Ernaehrungswissenschaft: Journal of Nutritional Sciences: Journal des Sciences de la Nutrition *(West Germany)*
Z. Erzbergbau Metallhuettenw.
Zeitschrift fuer Erzbergbau und Metallhuettenwesen *(Germany)*
Zesz. Nauk. Akad. Gorn.-Hutn. Krakowie, Rozpr.
Zeszyty Naukowe Akademii Gorniczo-Hutniczej w Krakowie, Rozprawy *(Poland)*

Zesz. Nauk. Mat., Fiz., Chem., Wyzsza Szkola Pedagog. Gdansku
*Zeszyty Naukowe Matematyka, Fizyka, Chemia, Wyzsza Szkola Pedagogiczna w Gdansku, Wydzial Matematyki, Fizyki i Chemii *(Poland)*

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Z. Flugwiss.
*Zeitschrift fuer Flugwissenschaften *(West Germany)*

Z. Gastroenterol.
*Zeitschrift fuer Gastroenterologie *(West Germany)*

Z. Geburtsh. Gynaekol.
Zeitschrift fuer Geburtshilfe und Gynaekologie *(Germany)*

Z. Geophys.
Zeitschrift fuer Geophysik *(West Germany)*

Z. Gesam. Exp. Med.
Zeitschrift fuer Gesamte Experimentelle Medizin Zugleich Fortsetzung der Zeitschrift fuer Experimentelle Pathologie und Therapie *(Germany)*

Z. Gesam. Hyg. Ihre Grenzgeb.
Zeitschrift fuer die Gesamte Hygiene und Ihre Grenzgebiete *(Germany)*

Z. Gesam. Inn. Med. Ihre Grenz.
Zeitschrift fuer die Gesamte Innere Medizine und Ihre Grenzgebiete *(Germany)*

Zh. Anal. Khim.
*Zhurnal Analiticheskoi Khimii† *(U.S.S.R.)*

Z. Haut-Geschlechtskrankh.
Zeitschrift fuer Haut- und Geschlechtskrankheiten *(Germany)*

Zh. Eksp. Klin. Med.
*Zhurnal Eksperimental'noi i Klinicheskoe Meditsiny *(Armenian S.S.R.)*

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Zh. Prikl. Khim.
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*Zhurnal Prikladnoi Spektroskopii, Akademiya Nauk BSSR *(Belorussian S.S.R.)*

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*Zhurnal Strukturnoi Khimii† *(U.S.S.R.)*

Zh. Tekh. Fiz.
*Zhurnal Tekhnicheskoi Fiziki† *(U.S.S.R.)*

Zh. Vses. Khim. Obshchest. Im. D. I. Mendeleeva
*Zhurnal Vsesoyuznogo Khimicheskogo Obshchestva Imeni D. I. Mendeleeva *(U.S.S.R.)*

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*Zhurnal Vychislitel'noi Matematiki i Matematicheskoi Fiziki *(U.S.S.R.)*

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*Zhurnal Vysshei Nervnoi Deyatelnosti imeni I. P. Pavlova *(U.S.S.R.)*

Z. Immunitaets-Allergieforsch.
*Zeitschrift fuer Immunitaets und Allergieforschung *(West Germany)*

Z. Indukt. Abstammungs- Vererbunsl.
Zeitschrift fuer Induuktive Abstammungs- und Vererbunslehre *(West Germany)*

Z. Instrum.
*Zeitschrift fuer Instrumentenkunde *(Germany)*

Z. Klin. Chem.
*Zeitschrift fuer Klinische Chemie *(Germany)*

Z. Klin. Med.
Zeitschrift fuer Klinische Medizin *(Germany)*

Z. Krebsforsch.
*Zeitschrift fuer Krebsforschung *(Germany)*

Z. Kreislaufforsch.
Zeitschrift fuer Kreislaufforschung *(Germany)*

Z. Kristallog.
*Zeitschrift fuer Kristallographie, Kristallogeometric, Kristallphysik, Kristallchemie *(Germany)*

Z. Laryngol., Rhinol., Otol.
Zeitschrift fuer Laryngologie, Rhinologie, Otologie und ihre Grenzgebiete *(Germany)*

Z. Lebensm.-Untersuch. Forsch.
Zeitschrift fuer Lebensmittel-Untersuchung und -Forschung *(Germany)*

Z. Med. Mikrobiol. Immunol.
Zeitschrift fuer Medizinische Mikrobiologie und Immunologie (formerly Zeitschrift fuer Hygiene und Infektionskrankheiten, Medizinische Mikrobiologie, Immunologie und Virologie) *(West Germany)*

Z. Menschl. Vererb.-Konstitutionslehre
Zeitschrift fuer Menschliche Vererbungs- und Konstitutionslehre *(Germany)*

Z. Metallk.
*Zeitschrift fuer Metallkunde *(Germany)*

Z. Meteorol.
*Zeitschrift fuer Meteorologie *(Germany)*

Z. Mikroskop.-Anat. Forsch.
Zeitschrift fuer Mikroskopisch-Anatomische Forschung *(Germany)*

Z. Naturforsch., a
*Zeitschrift fuer Naturforschung, Part a *(Germany)*

Z. Naturforsch., b
*Zeitschrift fuer Naturforschung, Part b *(Germany)*

Z. Naturwiss.-Med. Grundlagensforsch.
*Zeitschrift fuer Naturwissenschaftlich-Medizinische Grundlagensforschung *(Switzerland)*

Zool. Jahrb., Abt. Anat. Ontog. Tiere
Zoologische Jahrbuecher, Abteilung fuer Anatomie und Ontogenie der Tiere *(East Germany)*

Zool. Mag.
Zoological Magazine
see Dobutsugaku Zasshi

Z. Pflanzenernaehr. Dueng. Bodenk.
Zeitschrift fuer Pflanzenernaehrung Duengung Bodenkunde *(West Germany)*

Z. Pflanzenphysiol.
Zeitschrift fuer Pflanzenphysiologie *(West Germany)*

Z. Pflanzenzuecht.
*Zeitschrift fuer Pflanzenzuechtung *(Germany)*

Z. Phys.
*Zeitschrift fuer Physik *(Germany)*

Z. Phys. Chem. (Frankfurt)
*Zeitschrift fuer Physikalische Chemie (Frankfurt) *(Germany)*

Z. Phys. Chem. (Leipzig)
*Zeitschrift fuer Physikalische Chemie (Leipzig) *(Germany)*

Z. Physiol. Chem.
Zeitschrift fuer Physiologische Chemie, Hoppe-Seyler's *(Germany)*

Z. Rheumaforsch.
*Zeitschrift fuer Rheumaforschung *(Germany)*

Z. Schweisstech.
Zeitschrift fuer Schweisstechnik *(Switzerland)*

Z. Tierzuecht. Zuechtungsbiol.
Zeitschrift fuer Tierzuechtung und Zuechtungsbiologie *(West Germany)*

Z. Tropenmed. Parasitol.
*Zeitschrift fuer Tropenmedizin und Parasitologie *(West Germany)*

Zuechter
*Zuechter, Der *(Germany)*

Z. Urol.
Zeitschrift fuer Urologie *(Germany)*

Zvarenie
Zvarenie *(Czechoslovakia)*

Z. Vererbungsl.
Zeitschrift fuer Vererbungslehre *(Germany)*

Z. Vitamin-Hormon-Fermentforsch.
*Zeitschrift fuer Vitamin-Hormon- und Fermentforschung *(Austria)*

Z. Wiss. Photogr. Photophys. Photochem.
*Zeitschrift fuer Wissenschaftliche Photographie, Photophysik und Photochemie *(East Germany)*

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*Zeitschrift fuer Zellforschung und Mikroskopische Anatomie *(Germany)*

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